THE POTENTIAL FOR INTROGRESSION IN A BRITISH POLYPLOID COMPLEX

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by

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DECLARATION

I declare that this thesis is a record of my own work and that it has not been previously presented in application for a higher degree.

Lynn Taylor

St. Andrews,

September 1984.

CERTIFICATE

I certify that Lynn Taylor has spent 12 terms of research under my direction, and that she has fulfilled the conditions of Ordinance General No. 12 and Resolution of the University Court 1967 No. 1, and that she is qualified to submit the accompanying thesis in application for the degree of Doctor of Philosophy.

Ruth Ingram,

St. Andrews,

September 1984.

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ABSTRACT

The potential for introgression in the British Senecio polyploid complex was investigated using numerical taxonomic methods. It has been suggested that introgression of the introduced Mediterranean diploid S. squalidus L. into the native British tetraploid species S. vulgaris var. vulgaris (non-radiate) has given rise to the inland radiate morph S. vulgaris var. hibernicus Syme.

The research reported in this thesis falls into three main sections. The first part describes the results of a crossing program to determine the interfertility relationships of the British Senecio species, S. vulgaris var. vulgaris, S. vulgaris var. hibernicus, S. vulgaris var. denticulatus, S. viscosus, S. squalidus, S. vernalis, and S. cambrensis. Interspecific hybrids at the diploid, triploid and tetraploid levels were formed. If was found that hybrid fertility was largely dependent on genomic balance.

The phenetic similarities of the interspecific hybrids and the parental species were examined by multivariate analysis of 64 morphological charaters, using both cluster analysis and ordination methods. The results obtained suggest that radiate S. vulgaris may have arisen via non-reduction of a S. squalidus gamete. The backcross progeny of a tetraploid F_1 S. vulgaris var. vulgaris x S. squalidus hybrid were phenetically close to radiate S. vulgaris. However, F_2 progeny of naturally occuring triploid S. vulgaris x S. squalidus and S. x

subnebrodensis hybrids were found to have chromosome numbers between the diploid and sub-triploid levels. The diploid F_2 hybrids were morphologically indistinguishable from *S. squalidus*.

The third part of the thesis describes the results of a morphometric analysis of the geographic variation in radiate and non-radiate *S. vulgaris*, and *S. squalidus* in central Scotland. It was found that the interpopulation differentiation in both radiate and non-radiate *S. vulgaris* was correlated with both the geographic distribution of radiate *S. vulgaris* and the longitude.

In conclusion it is suggested that, although *S. vulgaris* var. *hibernicus* may have originated by introgresion of *S. squalidus* into *S. vulgaris* var. *vulgaris*, the current potential for introgression would appear to be in other directions, from the tetraploids *S. vulgaris* and *S. viscosus* into the diploid *S. squalidus*. The greatest extent of gene flow, however, was found to be from radiate *S. vulgaris* into non-radiate *S. vulgaris*.

CONTENTS.

1. INTRCDUCTION.

Although the literature on hybridization and introgression between plant species is extensive, and has recently been reviewed by Levin (1979) and Grant (1981), few authors are prepared to assess the relative importance of these phenomena in the evolution of plant species. Levin (1979) has stated that,

> "Our difficulty in assessing the role of interspecific gene exchange in evolution is principally attributable to our inability to detect and quantify gene exchange."

Gottlieb (1972) argues that although morphological intermediacy of a number of characters is the primary criterion of hybridity, other criteria such as additive inheritance of biochemical characters which are present in one parent but not in both, excessive interpopulation variability due to segregation, ecological and physiological intermediacy, the occurrence of partially fertile F_1 hybrids, and the experimental synthesis of the hybrid taxon, are necessary to determine the level of confidence that can be placed in the analysis.

Heiser (1973) suggests that although some cases of introgression have been well established, in many other cases an alternative explanation cannot be ruled out. Heiser lists a number of situations which may be mistaken for introgression but which are not, either because the initial hybridization has not occurred, or because there has not been repeated backcrossing. Examples of misleading cases are mutation, remnants of ancestral populations, segregants of segmental allopolyploids which resemble one parent, and primary intergradation. Thus in these cases the populations are continuous and therefore involve recombination rather than hybridization. Examples of the cases in which no recombination has occurred are F_1 hybrids, hybrid swarms, and recombinational speciation, where apparently introgressant forms result from inbreeding and selection after an initial hybridization.

Equally, as pointed out by Levin (1979) it is also possible to make the reverse mistake, to fail to detect introgression because of the absence of morphological variation. Lee (1975) found that although the F_1 hybrids of *Typha angustifolia* x *T. latifolia* were intermediate, the backcross hybrids were not distinguishable morphologically from *T. angustifolia*. Raven & Raven (1976) found that F_1 interspecific hybrids of *Epilobium* could not be distinguished morphologically from one of the parent species.

It has been suggested that both hybridization and introgression have occurred between various British species of *Senecio*. The hybridization of a number of *Senecio* species has been confirmed cytologically (Crisp, 1972; Benoit, Crisp & Jones, 1975; Ingram, 1977, 1978; Weir & Ingram, 1980). However, the possible introgressant forms (Crisp, 1972; Richards, 1975; Monaghan & Hull, 1976; Hull, 1976) have also been attributed to mutation (Stace, 1977) and recombinational speciation (Oxford & Andrews, 1977; Marshall & Abbott, 1980).

The evidence for introgression in the British *Senecio* polyploid complex is largely based on the univariate analysis of fitness characters such as germination rate, growth rate, and reproductive capacity in S. vulgaris (Richards, 1975; Oxford & Andrews, 1977), although backcross progeny of interspecific hybrids have been synthesized (Ingram, 1978; Ingram, Weir & Abbott, 1980).

The aim of this project was to re-examine the potential for interspecific gene transfer in British Senecio species using numerical taxonomic methods. Multivariate morphometric methods, although they sample the phenotype rather than the genotype, and therefore may be influenced by environmental variation, have been shown to be extremely powerful. It has been shown that morphometric analyses are superior to analyses of gene frequencies in both distiguishing genetic strains and sublines of mice, and discriminating between electrophoretically indistinguishable karyotipic races of mice (Thorpe, 1981; Thorpe, Corti, & Capanna, 1982).

Lewontin (1984) has shown that it is statistically much more difficult to demonstrate differences between gene frequencies than differences between the means of metric traits, and that this difficulty is independent of the gene frequencies or the variances of the metric characters. Lewontin argues that because of the *a priori*. differences in the statistical probabilities, a random set of loci cannot validly be compared with a quantitative trait, irrespective of whether or not the loci influence the trait.

It has been shown that morphometric size and shape variables are highly heritable (Atchley, 1983). Atchley, Rutledge, & Cowley, (1982) examined the genetic basis of biometrical divergence in 17 skull length and width characters in six genetic strains of rat. They found that the estimated narrow-sense heritabilities of the canonical vectors showed that the among-groups covariance patterns were highly heritable, and that there was a high correlation between the phenotypic and genetic distances in both males ($r = 0.90$) and females (0.85).

Multivariate analyses of morphological variation , in that they are statistically powerful methods, are extremely useful in investigating possible hybridization and introgression (Neff & Smith, 1979; Pimentel, 1981; Adams, 1982). A major part of this project is the application of such methods to an investigation of introgression in the British _Senecio_ species.

2. THE GENUS SENECIO IN BRITAIN.

2.1 Taxonomy and Distribution.

The genus Senecio (Asteraceae) is one of the largest known genera, comprising approximately 3000 species, and is cosmopolitan in its distribution. Chater & Walters (1976) in Flora Europea list nine species of *Senecio* as native to Britain: *S. paludosus* L., *S. smithii* DC., *S. integrifolius* (L.) Clairv., *S. jacobaea* L., *S. aquaticus* Hill, *S. erucifolius* L., *S. cambrensis* Rosser, *S. sylvaticus* L., and *S. vulgaris* L.; five species as naturalized: *S. doria* L., *S. mikanioides* Otto ex Walpers, *S. bicolor* (Willd.) Tod., *S. fluviatalis* Wallr., and *S. squalidus* L.; and one species *S. viscosus* L. as probably native to Britain. Crisp (1972) additionally lists *S. tanguticus* Maxim. as established in Britain, and a further 22 species of *Senecio*, including *S. vernalis* Waldst. & Kit., which have been recorded as occasional introductions.

Only six of these 38 species commonly occur in wild populations, the native tetraploids *S. jacobaea*, *S. aquaticus*, *S. viscosus*, *S. sylvaticus*, and *S. vulgaris*, and the introduced diploid *S. squalidus*. Chater & Walters (1976) placed *S. squalidus* in the section JACOBAEA (Miller) Dumort. with *S. jacobaea* and *S. aquaticus* on the basis of perennial habit, large capitula, and well developed ray florets. The annuals, *S. vulgaris*, *S. viscosus*, and *S. sylvaticus*, which have small, more or less cylindrical, capitula without ray florets (S. vulgaris) or with small ray florets (S. viscosus, S. sylvaticus) in the section SENECIO. Alexander (1976) treats all these species as belonging to sect. SENECIO on the basis of overall similarity and interfertility. However, the interfertility between these two groups in Britain would appear to be based on the ability of S. S. squalidus to form hybrids with S. vulgaris and S. viscosus. The hybrids S. jacobaea x S. squalidus and S. jacobaea x S. vulgaris have been recorded, but the records are doubtful, and the putative hybrids were probably depauperate S. squalidus plants (Benoit, Crisp & Jones, 1975).

The interfertility of S. squalidus with S. vulgaris and S. viscosus appears to have been responsible for the formation of a polyploid complex comprising interspecific hybrids, introgressant varieties, and an allohexaploid species, S. cambrensis Rosser.

For the purpose of this study the Senecio polyploid complex was defined as S. squalidus, S. sylvaticus, S. viscosus, S. cambrensis, S. vernalis, and S. vulgaris. The three varieties of S. vulgaris, S. vulgaris var. vulgaris, S. vulgaris var. hibernicus Syme, and S. vulgaris var. denticulatus O.F. Muell. were included.

S. squalidus is a perennial diploid (2n=20) ruderal of Mediterranean origin which is believed to have become established in Britain, having escaped from Oxford Botanic Gardens in the late 18th. century, and which is now common in disturbed habitats as far north as central

Scotland.

The two common varieties of S. vulgaris, the non-radiate morph var. vulgaris and the inland radiate morph var. hibernicus, are annual tetraploid (2n=40) ephemerals. These varieties are colonizers of open and disturbed habitats, and are capable of considerable phenotypic plasticity (Abbott, 1976a, 1976b). The third variant of S. vulgaris, the maritime radiate morph, S. vulgaris var. denticulatus, is a winter annual found only on sand dunes. The non-radiate morph var. vulgaris is common throughout Britain. The radiate morph var. hibernicus is broadly similar in distribution to S. squalidus, the northern limit of its distribution also being central Scotland. The maritime radiate morph var. denticulatus is only found in Lancashire and the Channel Is.

The other two tetraploid species, S. viscosus and S. sylvaticus are widespread in Britain. S. viscosus is commonly found on railway lines and open gravelly ground. S. sylvaticus is more commonly found at woodland margins, particularly on sandy soils. However, both species may be also found growing with S. squalidus and S. vulgaris on waste ground.

The hexaploid S. cambrensis (2n=60) is an annual or biennial ruderal found in roadsides and waste ground. It occurs only in a limited area of North Wales, although it has recently been found in Edinburgh (Abbott, Ingram, & Noltie, 1983).

The other diploid species included in this study, S.

vernalis, is also an annual ruderal of disturbed and open habitats, but occurs in Britain only as a rare introduction.

2.2 The origin of *S. vulgaris* var. *hibernicus*.

The evidence for the hypothesis that the inland radiate form of *S. vulgaris* has arisen by introgression of the introduced Mediterranean diploid *S. squalidus* into the native non-radiate *S. vulgaris* is based on three lines of evidence.

1. The apparently parallel spread of *S. squalidus* and *S. vulgaris* var. *hibernicus* in Britain over the past 150 years.
2. Studies which have suggested that the *S. vulgaris* var. *hibernicus* is intermediate between *S. squalidus* and *S. vulgaris* var. *vulgaris* for a number of characters.
3. Studies of synthesized hybrids and backcrosses of *S. vulgaris* var. *vulgaris* x *S. squalidus*.

1. *S. squalidus* was first recorded outside Oxford Botanic Gardens in 1794, and its spread has been well documented (Kent, 1956, 1957, 1963, 1964a, 1964b, 1964c, 1964d, 1966). *S. vulgaris* var. *hibernicus* was first recorded in Cork, Eire in 1866 (Syme, 1875), but did not become common in Britain until after 1900. Crisp (1972) argues that there was a good correlation between the distributions of *S. squalidus* and radiate *S. vulgaris* prior to 1930, with the radiate form appearing only after *S. squalidus* had become established in an area. Stace

(1977), however, points out that in many areas there is no obvious parallel colonization. In particular, in London and south-eastern England S. squalidus has been well established since 1900, but radiate S. vulgaris is still uncommon.

2. Richards (1975) compared germination, growth (plant height, number of leaves, time to flower, and longest leaf length), generation time, and reproductive potential (mean number of seeds per plant) in radiate and non-radiate plants from a British population with non-radiate plants from a Yugoslavian population. He found that the radiate plants had slower germination and growth, but a much higher reproductive capacity, than the non-radiate plants from the British population.

Oxford & Andrews (1977) examined the relative fitness of the radiate and non-radiate morphs in eight polymorphic natural populations in terms of the mean number of cypselae per capitulum and the mean number of capitula per plant. They found a highly significant genotype effect, the radiate form having having more capitula per plant, and more seeds per capitula, in six of the eight populations.

Monaghan and Hull (1976) compared leaf size (length and width) and shape (length to width ratio) in radiate and non-radiate S. vulgaris with S. squalidus from populations in Edinburgh and Glasgow. They found that radiate S. vulgaris was intermediate in leaf length between non-radiate S. vulgaris and S. squalidus leaf lengths. In the Edinburgh population, at which S.

squalidus was more frequent, both radiate and non-radiate plants had relatively broader leaves than in the Glasgow population S. vulgaris plants.

In reviewing this work, Stace (1977) argues that the evidence for the intermediacy of the radiate form of S. vulgaris is equivocal in that Richards (1975) found the Yugoslavian non-radiate S. vulgaris to be more like the radiate S. vulgaris from the British population with respect to growth than the British non-radiate S. vulgaris. Secondly, he argues that the leaf characters used by Monaghan & Hull (1976) are not good discriminators between S. vulgaris and S. squalidus as both species are highly variable in leaf shape and dissection. He further argues that, because of the rarity and almost complete sterility of the F_1 S. vulgaris x S. squalidus hybrid, it could not account for the rapid spread of radiate S. vulgaris.

3. Although some attempts to synthesize S. vulgaris x S. squalidus hybrids have been unsuccessful (Crisp, 1972; Alexander, 1975; Kadereit, 1984), others have been able to synthesize S. vulgaris var. vulgaris x S. squalidus and S. vulgaris var. hibernicus x S. squalidus F_1 triploids (2n=3x=30) (Harland, 1954; Gibbs, 1971; Ingram, 1977). It has been shown that fertile progeny can be obtained from the S. vulgaris var. hibernicus x hybrid (S. vulgaris var. hibernicus x S. squalidus), and the hybrid (S. vulgaris var. vulgaris x S. squalidus) x S. vulgaris var. vulgaris and var. hibernicus backcrosses (Ingram, Weir & Abbott, 1980) The backcross progeny had chromosome numbers between

2n=40 and 2n=44.

The frequency of *S. vulgaris* x *S. squalidus* hybrids in natural populations is difficult to assess in that, although many intermediates between the two species have been recorded (summarized in Crisp, 1972), only a few have been confirmed cytologically (Stace, 1977; Brettel & Leslie, 1978; Valentine, 1979). However, Ingram, Weir & Abbott (1980) found six triploids on a single visit to two sites in Edinburgh, and a further one triploid at Musselburgh. From comparison with synthesized hybrids they concluded that four of these were *S. vulgaris* var. *hibernicus* x *S. squalidus* , and three were *S. vulgaris* var. *vulgaris* x *S. squalidus*. Marshall & Abbott (1980) found eight *S. vulgaris* x *S. squalidus* hybrids from a total of 29,993 *S. vulgaris* plants at four sites (two in Edinburgh, one in Leeds, and one in Cardiff)and, from progeny testing of 50 radiate and 50 non-radiate plants from each site, obtained a single hybrid out of 9469 progeny of radiate plants, and one hybrid from 6392 progeny of non-radiate plants.

The alternative hypothesis to an introgressive origin of the radiate form of *S. vulgaris* is that it arose by mutation. The ray floret character in *S. vulgaris* var. *hibernicus* is controlled by a single gene with incomplete dominance (Trow, 1912). The non-radiate form is the homozygote *TnTn*, the radiate form is the homozygote *TrTr*, and the heterozygote (*TnTr*) has short, stubby ray florets. Stace (1977) lists a number of species of the Asteraceae in which mutations from a radiate to a non-radiate condition have occurred (Aster tripolium, Leucanthemum vulgare), and vice versa (Bidens cernua), and points out that non-radiate variants of Senecio jacobaea and S. squalidus have been recorded. The non-radiate condition in S. squalidus has also been found to be controlled by a single gene with incomplete dominance (Ingram & Taylor, 1982).

In a recent series of papers Marshall & Abbott (1979, 1980, 1982, 1984) have shown that the radiate form of S. vulgaris generally has a much higher outcrossing frequency than the non-radiate form. In wild polymorphic populations the non-radiate morph is predominately self-fertilizing, generally outcrossing at a frequency of less than 1%; whereas the radiate morph consistently shows much greater levels of outcrossing, reaching 30% in some populations. Although there were large fluctuations in the frequencies of the Tr and Tn alleles between 1978 and 1980, the differences in outcrossing frequency were maintained.

Theoretical studies on the evolution of mixed mating systems in plants, i.e., species in which both self-fertilization and outcrossing occur, generally conclude that, at least in single locus models, an allele which promotes outcrossing is at a selective disadvantage when compared with an allele which promotes selfing, unless the genetic cost of outcrossing is balanced by some form of selective advantage (Fisher, 1941; Moran, 1962; Nagylaki, 1979). Inbreeding depression in the selfing variant and/or greater fitness or reproductive capacity in the outcrossing variant have been suggested as factors on which selection may act to maintain the frequency of the outcrossing gene in the population (Charlesworth & Charlesworth, 1979; Lloyd, 1979,).

The question of which factors control the spread of the radiate morph is the subject of a research program currently being carried out at St. Andrews (Abbott, pers. com.). This project is primarily a study of the origin of the radiate morphs S. vulgaris var. hibernicus and var. denticulatus.

If the effects associated with the radiate allele are due to pleiotropy, then it is not possible to determine whether it has originated as a result of mutation or introgression. However, if the effects are due to linkage, then this would be evidence in favour of an introgressive origin. The pleiotropy and linkage can only be distiguished by the presence of recombinants, the frequency of which is dependent on the degree of linkage.

2.3 The origin of S. vulgaris var. denticulatus.

The maritime radiate form var. denticulatus, has a limited and disjunct distribution in Britain, being found on sand dunes in only two areas; between Liverpool and Southport on the Lancashire coast, and on the Channel Islands. Although var. vulgaris , var. hibernicus and var. denticulatus are fully interfertile, the maritime radiate form is morphologically and phenologically distinct. S. vulgaris var. denticulatus is a winter annual with a basal rosette growth habit. The basal leaves are much longer and more spathulate than those of var. vulgaris and var. hibernicus. The indumentum is arachnoid rather than sparsely pubescent. The capitula of var. denticulatus are slightly larger, and the ray florets smaller, than those of the other two forms.

The similarity of growth habit and leaf shape between S. vulgaris var. denticulatus and S. vernalis has led to the suggestion (Crisp, 1972) that var. denticulatus may have arisen either as a result of introgression of S. vernalis into S. vulgaris var. vulgaris, or as a result of autotetraploidization of S. vernalis (Kadereit, 1984a).

Kadereit (1984) synthesized triploid hybrids of S. vulgaris var. vulgaris x S. vernalis and S. vulgaris var. denticulatus x S. vernalis, and tetraploid hybrids between S. vulgaris var. vulgaris and synthetic autotetraploids of S. vernalis. The triploid hybrids had pollen fertilities of 9.5% and 8.0% to 15% respectively, and the tetraploid hybrids had a mean pollen fertility of 79.9%. Kadereit suggests that S. vulgaris var. denticulatus arose by autotetraploidization of S. vernalis, and that subsequent differentiation at the tetraploid level gave rise to the non-radiate S. vulgaris var. vulgaris. That is, he suggests that S. vulgaris is a autotetraploid rather than an allotetraploid as suggested by Ingram (1978). Kadereit argues that the lower incidence of univalent formation in the F_1 triploid hybrids of S. vulgaris and the annual diploid species S. glaucus ssp. glaucus, S. leucanthemifolius, and S. vernalis (5.5 - 6.4 univalents per cell) as compared with the 7 - 10 univalents per cell in the F_1 S. vulgaris x S. squalidus triploid (Ingram, 1977) indicates a closer relationship between these species and S. vulgaris than between S. squalidus and S. vulgaris.

Based on the calculations of Jackson & Casey (1982) and Jackson & Hauber (1982), nine univalents would be expected with totally homologous pairing in an autotriploid if the chiasma frequency is 11.42 + 0.47 chiasmata per cell, as has been recorded in S. squalidus from North Wales (Ingram & Noltie, in prep.).

A higher chiasma frequency would increase multivalent formation at the expense of univalent formation, and therefore, unless these factors have been taken into account, the number of univalents in a triploid hybrid cannot be used to indicate genomic relationships.

2.4 The origin of S. cambrensis.

S. cambrensis was first described by Rosser (1955) who defined it as a allohexaploid (2n=60) formed by hybridization of S. squalidus and S. vulgaris. The allohexaploid has been synthesized by colchicine induced autopolyploidy of the F_1 S. vulgaris x S. squalidus hybrid (Harland, 1954; Ingram & Weir, 1980) who found that the resultant plants closely resembled the wild ones. They were intermediate between the parental species in morphology, but had larger cypselae, and pollen with four pores rather than three.

Until recently it was believed that *S. cambrensis* had a restricted distribution, occuring only in the Ffrith area of North Wales where it was originally recorded (Rosser, 1955), but it has now also been found in Edinburgh (Abbott, Ingram & Noltie, 1983). It has been suggested that this may be an example of an alloployploid being formed *de novo* as the triploid *S. vulgaris* x *S. squalidus* hybrid has been recorded in the same area (Ingram, Weir & Abbott, 1980; Marshall & Abbott, 1980).

2.5 Introgression of *S. squalidus* into *S. viscosus*.

The triploid hybrid between *S. squalidus* and *S. viscosus* is *S.* x *subnebrodensis* Simk., this name having been shown to have priority over the better known *S.* x *londinensis* Lousley (Kadereit, 1984b). *S.* x *subnebrodensis* is fairly common on sites where the two parental species occur. The hybrid is morphologically intermediate between the parents, but is more like *S. viscosus* in its degree of viscidity (Benoit, Crisp & Jones, 1975).

Crisp & Jones (1978), in an investigation of natural and synthesized *S.* x *subnebrodensis*, found that the triploid could only be synthesized when *S. squalidus* was the female parent. Although they found that controlled self-pollination and attempts to backcross the hybrids to either parental species were unsuccessful, spontaneous F_2 progeny from both natural and synthesized hybrids were obtained. These F_2 hybrids were either triploid (2n=30) or sub-pentaploid to sub-hexaploid ($2n=47$ to $2n=56$), and were all almost sterile, with seed sets of less than 0.5%. One of the triploid F_2s gave rise to a large and vigorous F_3 with $2n=48$, which in turn produced F_4s with $2n=43$ and $2n=44$. There was a gradual increase in the pollen stainability and seed set from the F_2 to the F_4 generations.

Crisp & Jones suggest that introgression of the diploid S. squalidus into the tetraploid S. viscosus may occur via aneuploidy of approximately pentaploid later generation hybrids.

2.6 Hybridization between the tetraploid species.

S. x viscidulus Scheele, the hybrid of S. sylvaticus and S. viscosus, has been recorded with reasonable regularity (Benoit, Crisp & Jones, 1975), and has been synthesized with relative ease (Crisp, 1972). However, there are no records of later generation hybrids, and no evidence to suggest that introgression of this hybrid into either parent species occurs.

The hybrid of S. viscosus and S. vulgaris has been recorded, although these records have not been confirmed (Benoit, Crisp & Jones, 1975). Attempts to synthesize this hybrid have failed, and Gibbs (1971) found evidence of hybrid embryo inviability. There are no confirmed records of hybrids of S. vulgaris and S. sylvaticus.

2.7 Summary.

The pathways of possible interspecific gene transfer which have been suggested as occurring between the British *Senecio* species; *S. vulgaris* var. *vulgaris*, *S. vulgaris* var. *hibernicus*, *S. vulgaris* var. *denticulatus*, *S. squalidus*, *S. cambrensis*, *S. viscosus*, *S. sylvaticus*, and *S. vernalis*; are summarized in Figure 2.7.1.

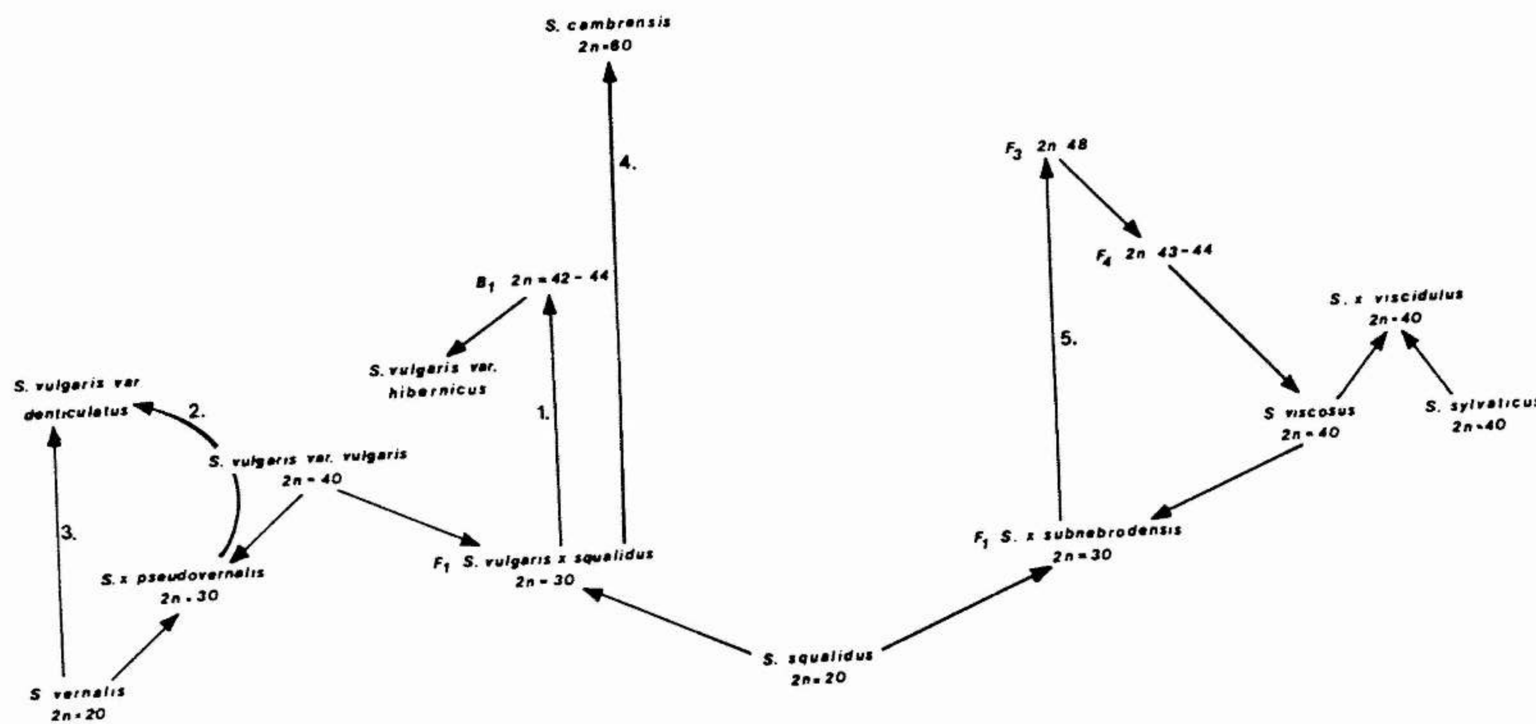


FIGURE 2.7.1 Summarizing the possible pathways of interspecific gene flow which have been suggested to occur between the British <u>Senecio</u> species.

3. THE AIMS AND EXTENT OF THE PROJECT.

The aim of this project was to re-examine the possible introgression of S. squalidus into S. vulgaris and S. viscosus. This problem was approached in three stages.

The first series of experiments was a crossing program to determine the interfertility of the species, and to synthesize the interspecific hybrids.

The second series of experiments was a morphometric analysis of the interspecific hybrids, their parental species, and the putative introgressant forms. The aim of this series of experiments was to examine the variability in plants which are known *a priori* to be hybrids, and therefore to generate a known model of phenetic similarity in the *Senecio* polyploid complex, which could be compared with the variation found in natural populations.

The third approach was a morphometric analysis of geographic variation in natural populations. The area in central Scotland which was studied extends across the northern limit of the distributions of *S. squalidus* and radiate *S. vulgaris*. The aim of this analysis was to locate naturally ocurring hybrids, and to compare the pattern of variation in these, and their parental species, with both the geographic distribution of *S. squalidus* and radiate *S. vulgaris*, and with the 'known' model of the synthesized hybrids and introgresants.

4. THE USE OF NUMERICAL METHODS IN PLANT SYSTEMATICS

A wide range of numerical taxonomic methods have been applied to plant systematics, and the literature on theoretical and general methodological aspects, and on specific methods is extensive (Jardine & Sibson, 1971; Blackith & Reyment, 1971; Sokal & Rohlf, 1981; Wiley, 1981; Gordon, 1981). However, Duncan & Baum (1981) have suggested that the application of these methods appears to be largely _ad hoc_, in that in many papers the similarity coefficients used are often not specified, or the reaosns why specific methods have been used are not given.

The application of numerical methods can be regarded as a multistage decision process (Crovello, 1970), the four main stages of this process being,

1. The choice of the OTUs.
2. The choice of the characters to describe the OTUs.
3. The methods of computing the similarity of the OTUs.
4. The method of evaluating the taxonomic structure within the similarity matrix.

1. The operational taxonomic units or OTUs, may be either individuals, populations, species, genera or any higher taxonomic level. The choice of the OTUs is neccesarily dependent on the aim of the specific study being conducted, although it has been argued that, in general, the OTUs should be homogeneous with respect to all relevant external criteria, i.e., taxonomic rank, climatic, edaphic, ecological or geographical variables (Jardine & Sibson, 1971). In this study the OTUs were individual

plants.

2. The choice of the number and type of the characters, i.e., binary, multistate, or quantitative, is dependent on the number of OTUs to be classified, the taxomonic rank of the OTUs, and the type of data used, i.e., biochemical, morphological, allozyme frequency or ecological data. This study, as an investigation of possible introgression between five closely related species, used primarily quantitative morphometric data. Sneath & Sokal (1973) suggested than between 40 and 60 characters was the optimal number of characters for the majority of numerical studies. Baum & Duncan (1981) have argued that there is no a priori correct number of characters, and that the selection of characters is dependent on detailed understanding of their within- and between-OTU variation. In this study, as the characters were numeric, the variation and the correlation of the characters could be determined statistically.

3. There are three main classes of similarity coefficients; correlation coefficients, such as the product-moment correlation coefficient; distance coefficients, such as euclidean distance, Mahalanobis D (Mahalanobis, 1936), or the Canberra metric (Lance & Williams, 1966), and association coefficients, such as the general similarity coefficient of Gower (1971). Duncan & Baum (1981) have pointed out that the choice of a suitable similarity coefficient requires adequate knowledge of both the data and the effect of different coefficients. The use of correlation coefficients, for example, has been

criticized by Eades (1965) and Minkoff (1965) who have shown that the correlation coefficient requires all the characters to have the same directional and dimensional properties. However, as pointed out by Sneath & Sokal (1973) the properties of the various coefficients have, in general been determined empirically (Sokal & Michener, 1967; Boyce, 1969; Schnell, 1970) by comparison with a known model, and therefore, in that the structure of the data is not known in advance in any given study, there can be no a priori best similarity coefficient. Gordon (1981) states that,

> "the author is loath to make any exclusive recommendations, because of the many different types of data which can appear in classification studies."

Sneath and Sokal (1973) state that,

> "Perhaps the only recommendation that we would care to make at this stage in the development of the field is that, of each type of coefficient considered, the simplest one should be chosen out of consideration for ease of interpretation."

4. There are two main classes of methods of evaluating the taxonomic structure of the similarity or distance matrix, ordination methods and hierarchical clustering methods. The unweighted pair group method (UPGMA) of heirarchical clustering (Sokal & Michener, 1958) is the most commonly used numerical analysis (Duncan & Baum, 1981). However, in cases where the variation is not of a hierarchical nature, as for example in studies of interspecific hybridization and introgression, or of intraspecific geographic variation, then ordination methods, such as principal component analysis, principal coordinate analysis, canonical variate or discriminant

function analysis, and non-metric multidimensional scaling are commonly used.

A number of papers have been published comparing the use of various ordination methods in the detection and analysis of hybrids. Neff & Smith (1979) compared the use of discriminant function analysis and principal component analysis in analysing hybrids from two sunfish genera, *Lepomis* and *Notropis*. Pimentel (1981) compared principal component analysis, principal coordinate analysis, and non-metric multidimensional scaling, using data from a hybrid swarm of *Abronia*. Adams (1982) compared the ordinations obtained from a hybrid index (Wells, 1980), principal component analysis, principal coordinates analysis, and discriminant function analysis using data from *Lepomis* and from *Juniperus*.

Both Neff & Smith (1979) and Adams (1982) in comparing discriminant function analysis with the other ordination methods point out that the necessity of a priori definition of the groups in discriminant function analysis makes this method unsuitable for the initial detection of hybrids. Neff & Smith (1979) found that where the parental species were defined as the *a priori* groups and the hybrids were classed as unknowns, then the hybrids were grouped with one of the parent species. However, where three *a priori* groups were defined, the individuals were all classed correctly. In a discriminant function analysis an OTU can only be classed with a pre-defined group, and therefore the use of discriminant function analysis to detect hybrids initially is paradoxical.

Neff & Smith (1979) and Adams (1982) further argue that the requirements of multivariate normality and equality of variance-covariance matrices in discriminant function analysis limit its usefulness. Neff & Smith (1979) found that aberrant specimens gave unpredictable results in the discriminant function analysis, which were not found in the principal component analysis. Adams (1982) found that transgressive character states gave similar unpredictable results in discriminant function analysis.

Pimentel (1981) found that principal coordinate analysis and non-metric multidimensional scaling performed better than principal component analysis. Adams (1982) found that an F-ratio weighted hybrid index and F-ratio weighted principal coordinate analysis performed better than discriminant function analysis and principal component analysis. Thorpe (1980) examined the effect of different types of standardization, similarity coefficients, and ordination methods on the analysis of racial differentiation in the ringed snake Natrix natrix. He found that discriminant function analysis and principal component analysis of standardized data were preferable to principal component analysis of unstandardized data, principal coordinate analysis, and non-metric multidimensional scaling.

Discriminant function analysis differs from the other methods in that it has the desirable property of being able to negate the information redundancy due to character correlation by using the pooled-within groups correlation.

The disadvantage of discriminant function analysis, however, is that it requires equality of the within-group covariance matrices. Thorpe (1983) argues that when discriminant function analysis is used to ordinate homogeneous a priori defined groups based on local populations, then the within-group covariance matrices are less likely to be heteroscedastic, than if used to discriminate between predefined taxa or widespread races.

However, these comparisons of the ordinations obtained using different methods are empirical in approach, in that they compared the ordinations obtained with a 'known' taxonomic model. Therfore, unless the taxonomic structure is known in advance, one cannot argue that any method is the most appropriate for a given data set. Similarly these arguments apply to the choice of cluster analysis methods.

The aim of this project was to examine th pattern of variation in a possible species-hybrid-introgressant complex, and therefore, in that the taxa studied were both closely related, and phenotypically plastic, the optimal character set was initially considered to be the maximum number of non-redundant quantitative characters.

As the characters were quantitative, the similarity coefficient used was the euclidean distance, and, given the different properties and assumptions of the various ordination and clustering methods, two ordination methods, discriminant function analysis and principal component analysis, and two clustering methods, the unweighted pair group (UPGMA) method (Sokal & Michener, 1958) and the error sum of squares (ESS) method (Ward, 1963) were used to assess the phenetic similarities of the interspecific hybrids and their parental species in this study. The assumption was made that, if the resultant classifications using these various methods agreed, then they may be taken as having some form of biological meaning, rather than being artifacts of the numerical methods used.

5. THE CHOICE OF A CHARACTER SET.

5.1 Formulation and definition of the characters.

The Senecio species which form the basis of this study are closely related, and there are few qualitative differences between them. The viscid indumentum which is characteristic of S. viscosus may be considered, for reasons which are discussed later, a quantitative character. Capitulum morphology in the sect. SENECIO is generally uniform, and formal taxonomic treatments of the European members of this group (Alexander, 1975; Chater & Walters, 1976) are largely based on quantiative differences in capitulum size and shape, and ray floret development; and on vegetative characters such as growth habit and leaf shape.

The character set used in this study comprises 64 characters, of which 63 are meristic or continuous variables and one is a multistate character. Two of the continuous characters are ratios.

Of the 64 characters, 34 are vegetative characters, 8 of these decribing growth habit, and 26 describing middle cauline leaf shape. Of the 30 capitular characters, 19 are based on the dimensions of the capitulum and its component parts, the involucre and the disc florets; 4 are indumentum characters; and 7 are ray floret characters.

The 26-character subset used to describe middle cauline leaf shape is based on the architectural character set developed by Blackburn (1978) to classify leaves of

Saurauia (Actinidiaceae). The definition of the vein orders used was that of Hill (1980) whereby secondary and intersecondary veins are distinguished on the basis of rank ordering of the vein length multiplied by the vein width at the point of insertion into the primary vein. Some modification of these systems was necessary for use with the highly dissected leaves of _Senecio_. In particular, it was necessary to define the point of origin of the apical lobe, the extent of the auricle, and the geometry of the lobes.

In the 30-character subset used to describe the capitulum, the 4 indumentum characters were based on the relative density of two classes of trichomes on two parts of the invulucre, the calyculus bracts and the phyllaries. Crisp (1972) characterized the leaf trichomes of the British _Senecio_ species as either glandular or non-glandular, the non-glandular trichomes being subdivided into two types, ´club´ trichomes with a bulbous terminal cell, and ´whip´ trichomes with a slender, sinuous terminal cell. In this study the density of the glandular trichomes (glands) and the non-glandular trichomes (hairs) were treated as separate characters. Distinction was not made between the two types of hairs, because of the excessive ammount of time this would have required. Similarly, distinction was not made between the large viscid glands of _S. viscosus_ and the smaller appressed glands of _S. vulgaris_, _S. sylvaticus_ and _S._ squalidus. It was found that in hybrids of _S. viscosus_ and _S. squalidus_ the glands were intermediate in size as well as number between those of _S. viscosus_ and _S. squalidus_.

The presence of ray florets is the diasgnostic character in distinguishing _S. vulgaris_ var. _vulgaris_ (rayless) from _S. vulgaris_ var. _hibernicus_ and _S. vulgaris_ var. _denticulatus_ (both rayed). As this character is controlled by a single gene with incomplete dominance the formulation of this character was considered in some detail.

If the genotype _TnTn_, the non-radiate condition in _S. vulgaris_, is characterized as the absence of ray florets, i.e., as a binary character (+/-) or as the meristic character ´Number of ray florets´ equals 0, then the other characters based on the ray florets, e.g., length, width, etc., are conditionally present characters. This has the effect of giving excessive weighting to the single gene which controls this polymorphism.

Two lines of evidence, however, suggest that the _Tn_ allele controls the presence of disc florets rather than the absence of ray florets. Ingram & Taylor (1982) found that in _S. squalidus_ in which the non-radiate condition is also controlled by a single gene with incomplete dominance, there was an inverse correlation between ray floret length, the development of the androecium, and the degree of fusion of the corolla. That is, the heterozygotes were intermediate between the ray and the disc florets in morphology as well as length.

If the _Tn_ allele results in the alteration of the ray florets into disc florets, rather than the simple absence of ray florets, then one would expect that the number of of disc florets in non-radiate S. vulgaris would be the same as the number of disc florets plus the number of ray florets in S. vulgaris var. hibernicus.

A t-test was used to compare the number of disc florets in 15 replicates of non-radiate S. vulgaris (Line No. 11) with 15 radiate S. vulgaris plants (Line No. 21). Both of these lines originally came from the same population (Appendix 1). The non-radiate plants had a mean of 53.000 disc florets per capitulum, and the radiate plants had a mean of 44.067 disc florets per capitulum, which gave $t = 3.87$, $p = 0.001$. If the total number of florets per capitula were compared then $t = -0.06$, which gives $p = 0.956$. That is there was no statistically significant difference between the total number of florets in radiate and non-radiate S. vulgaris. For this reason the ray florets were considered to be ´outer florets´, and measurement of the characters in the non-radiate plants was done on the outer ring of disc florets.

5.2 Materials and methods.

23 purebred lines of the 8 species and varieties; S. vulgaris var. vulgaris, S. vulgaris var. hibernicus, S. vulgaris var. denticulatus, S. squalidus, S. cambrensis, S. viscosus, S. sylvaticus, and S. vernalis; comprising a total of 456 plants, plus 15 interspecific hybrid lines, and one colchicine-induced autotetraploid S. squalidus

line, comprising a total of 115 plants, were grown under standardized conditions.

The 571 plants were grown in 3 batches, the first being sown on the 18th. June 1982, the second on the 9th. May 1983, and the third on the 1st. September 1983. All seeds were sown in trays of Levington compost, and pricked out at 21 days after sowing. The plants in the first batch were potted on into 5-inch pots of John Innes No. 2 compost. The plants in the second and third batches were grown in 5-inch pots of soil mixture. The plants grown in September 1983 were given supplementary lighting to maintain a 16 hour photoperiod.

All plants were harvested on the first day of full anthesis of the apical capitulum. Measurement of the vegetative characters C02 to C08 (Plant Height, Inflorescence Length, Number of Internodes, Basal Stem Diameter, Number of Leaves, Proportion of Lateral Shoots with Capitula, and Longest Leaf Length) were made on fresh material. Measurement of the length characters C02, C03, C05 and C08 was to the nearest millimetre. The leaf nearest to the midpoint of the plant height (the midleaf) was removed, placed in a polythene bag, and deep frozen.

The apical capitulum was dissected, characters C35 to C47 plus character C53 were measured or counted during dissection. The calyculus bracts, the outer florets, and a sample of 10 disc florets from the center of the capitulum, were placed on Sellotape and mounted on microscope slides. Characters C48 to C52 and C54 to C63 were measured from the slides at either x15 or x30 using an eyepiece graticule. Characters which were single measurements were made to the nearest 0.05 mm. Characters which were means or ranges of multiple measurents were calculated to the nearest 0.01 mm.

After harvesting was complete, characters C09 to C34 were measured on the frozen leaf material. Linear measurements were to the nearest mm, and angular measurements were to the nearest degree.

5.3 The character set.

C01 Days to Flowering.

Defined as the number of days between the seed sowing and full anthesis of the apical capitulum.

C02 Plant Height.

The length from the base of the stem, defined as the cotyledon node, to the level of the stigmas of the apical capitulum.

C03 Inflorescence Length.

The length from the apical stem node, defined as the node subtending the apical capitulum, to the level of the stigmas of the apical capitulum.

C04 Number of Internodes.

The number of internodes between the cotyledon node and the apical stem node.

C05 Basal Stem Diameter.

The diameter of the stem at the cotyledon node.

C06 Number of Leaves.

Defined as the total number of leaves excluding the cotyledons.

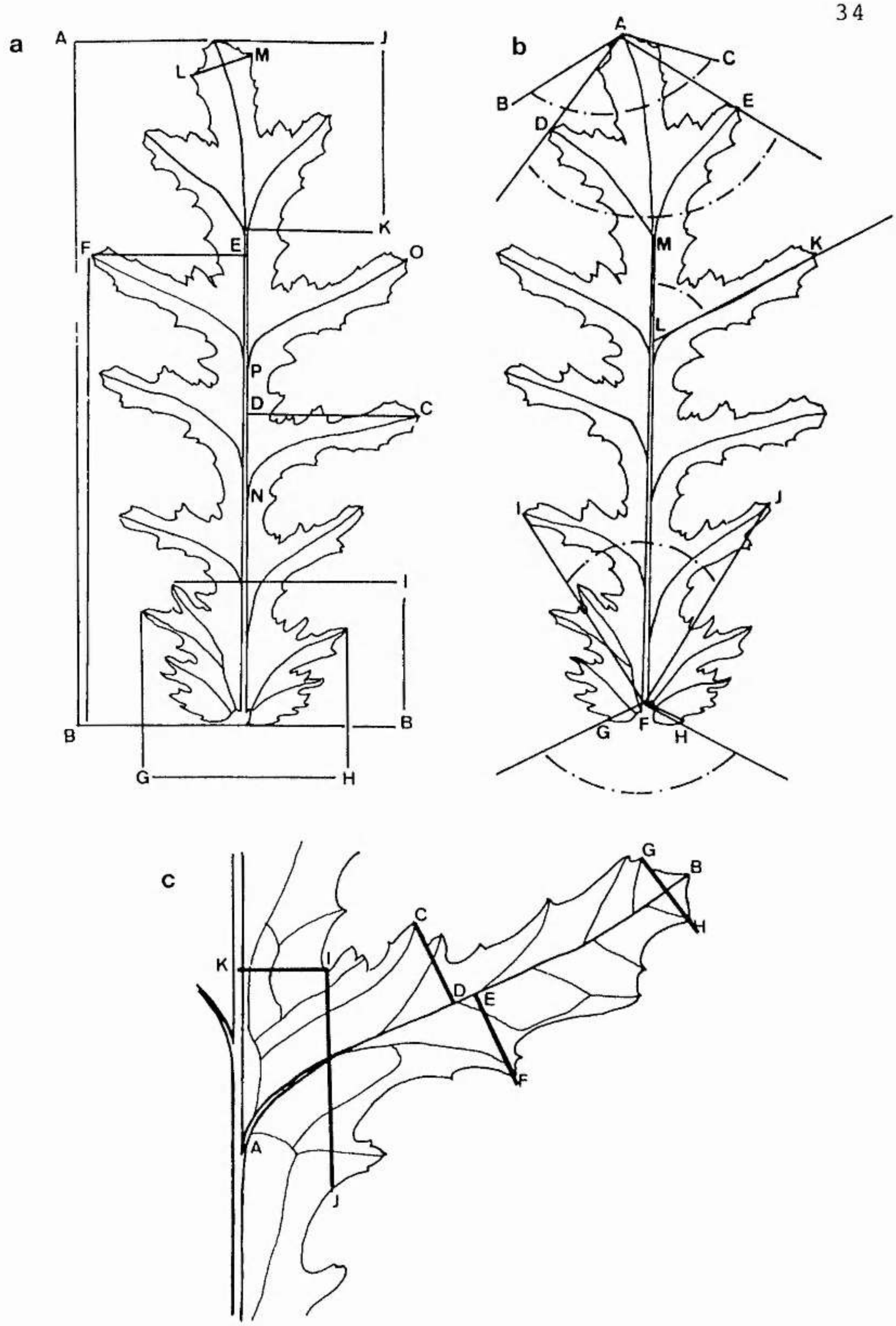


FIGURE 5.3.1 Drawing of the midleaf (MLF) of S. vulgaris showing (a) the length characters C09 to C18, and C28, C29, (b) the angular characters C30 to C34, and (c) the Mid-Lobe characters C19 to C27.

C07 Proportion of Laterals with Capitula.

The number of lateral buds and/or branches with capitula divided by the total number of lateral buds and/or branches.

C08 Longest Leaf Length.

Length of the longest leaf, measured parallel to the primary vein.

C09 Midleaf Length

Maximum length of the midleaf (MLF), defined as the leaf attached to the stem nearest to the the midpoint of the plant height (C02). Measured parallel to the primary vein, from the base of the auricle to the apex of the primary vein. Length AB in Figure 5.3.1a.

C10 MLF Max Width R.

The maximum width of the midleaf, measured perpendicular to the primary vein on the right-hand side of the primary vein. Length CD in Figure 5.3.1a.

C11 Mlf Max Width L.

Defined as character C10, except measured on the left-hand side of the primary vein. Length EF in Figure 5.3.1a.

C12 MLF Base to Max Width R.

Defined as the length from the base of the midleaf to the point at which C10 (MLF Max Width R) intersects with the primary vein. Length BD in Figure 5.3.1a.

C13 MLF Base to Max Width L.

Defined as the length from the base of the midleaf to the point at which C11 (MLF Max width L) intersects with the primary vein. Length BF in Figure 5.3.1a.

C14 MLF Auricle Length.

The maximum length of the midleaf auricle, measured parallel to the primary vein, the auricle being defined as that part of the basal lamina in which the veins originate in the stem, i.e., below the base of the primary vein. Length BI in figure 5.3.1a.

C15 MLF Auricle Width.

Maximum width of the midleaf auricle, measured perpendicular to the primary vein. Length GH in Figure 5.3.1a.

C16 MLF Number of Lobes.

Defined as the number of secondary veins plus the apical lobe. The apical lobe is defined as originating at the point at which the secondary veins are of equal thickness to the primary vein. Point M in Figure 5.3.1b.

C17 MLF Apical Lobe Length.

Length of the apical lobe measured parallel to the primary vein. Length KJ in Figure 5.3.1a.

C18 MLF Apical Lobe Width.

The sum of the maximum widths of the apical lobe on both sides of the primary vein. Measured perpendicular to the primary vein. Length LM in Figure 5.3.1a.

C19 MLF Longest Lobe Length.

Defined as the length of the longest secondary vein. Length OP in Figure 5.3.1a.

C20 MLF Mid-Lobe Length.

Defined as the length of the secondary vein occuring nearest to the midpoint of the primary vein length. Length AB in Figure 5.3.1c.

C21 MLF Mid-lobe Max Width A.

Defined as the maximum width of the Mid-lobe on the apical side of the secondary vein, measured perpendicular to the secondary vein. Length CD in Figure 5.3.1c.

C22 MLF Mid-Lobe PV to Max Width A.

Defined as the length from the primary vein to the point at which character C21 (MLF Mid-Lobe Max Width A) intersects the secondary vein. Measured parallel to the secondary vein. Length AD in Figure 5.3.1c.

C23 MLF Mid-lobe Max Width B.

The maximum width of the Mid-Lobe on the basal side of the secondary vein, measured perpendicular to the secondary vein. Length EF in Figure 5.3.1c.

C24 MLF Mid-Lobe PV to Max Width B.

The length from the primary vein to the point at which character C23 intersects with the secondary vein. Measured parallel to the secondary vein. Length AE in Figure 5.3.1c.

C25 MLF Mid-Lobe Apical Width.

Defined as the sum of the lengths from the marginal ends of the tertiary veins adjacent to the apex of the Mid-Lobe secondary vein to the points of intersection with the secondary vein. Length GH in Figure 5.3.1c.

C26 MLF Mid-Lobe Basal Width.

Width of the Mid-Lobe between the points of exmedial curvature of the leaf margin, measured parallel to the primary vein. Length IJ in figure 5.3.1c.

C27 MLF Mid-Lobe Lamina Width.

The width of the primary lamina, from the centre of the primary vein to the point of intersection of C26 (MLF Mid-Lobe basal Width) with the leaf margin. Measured perpendicular to the primary vein. Length KI in Figure 5.3.1c.

C28 MLF Intercostal Length A.

Length from the point of intersection of the Mid-Lobe secondary vein with the primary vein to the point of insertion of the apically adjacent secondary vein in the primary vein. Length DP in Figure 5.3.1a.

C29 MLF Intercostal Length B.

Defined as C28, except measured to the basally adjacent secondary vein. Length DN in Figure 5.3.1a.

C30 MLF Apical Angle A.

Defined as the angle between the apex of the primary vein and the apices of adjacent marginal tooth sinuses. Angle BAC in Figure 5.3.1b.

C31 MLF Apical Angle B.

Defined as the angle between the apex of the primary vein and the apices of the adjacent secondary veins. Angle DAE in Figure 5.3.1b.

C32 MLF Basal Angle A.

The angle between the base of the primary vein and the most basal auricle lobes on either side of the primary vein. Angle GFH in Figure 5.3.1b.

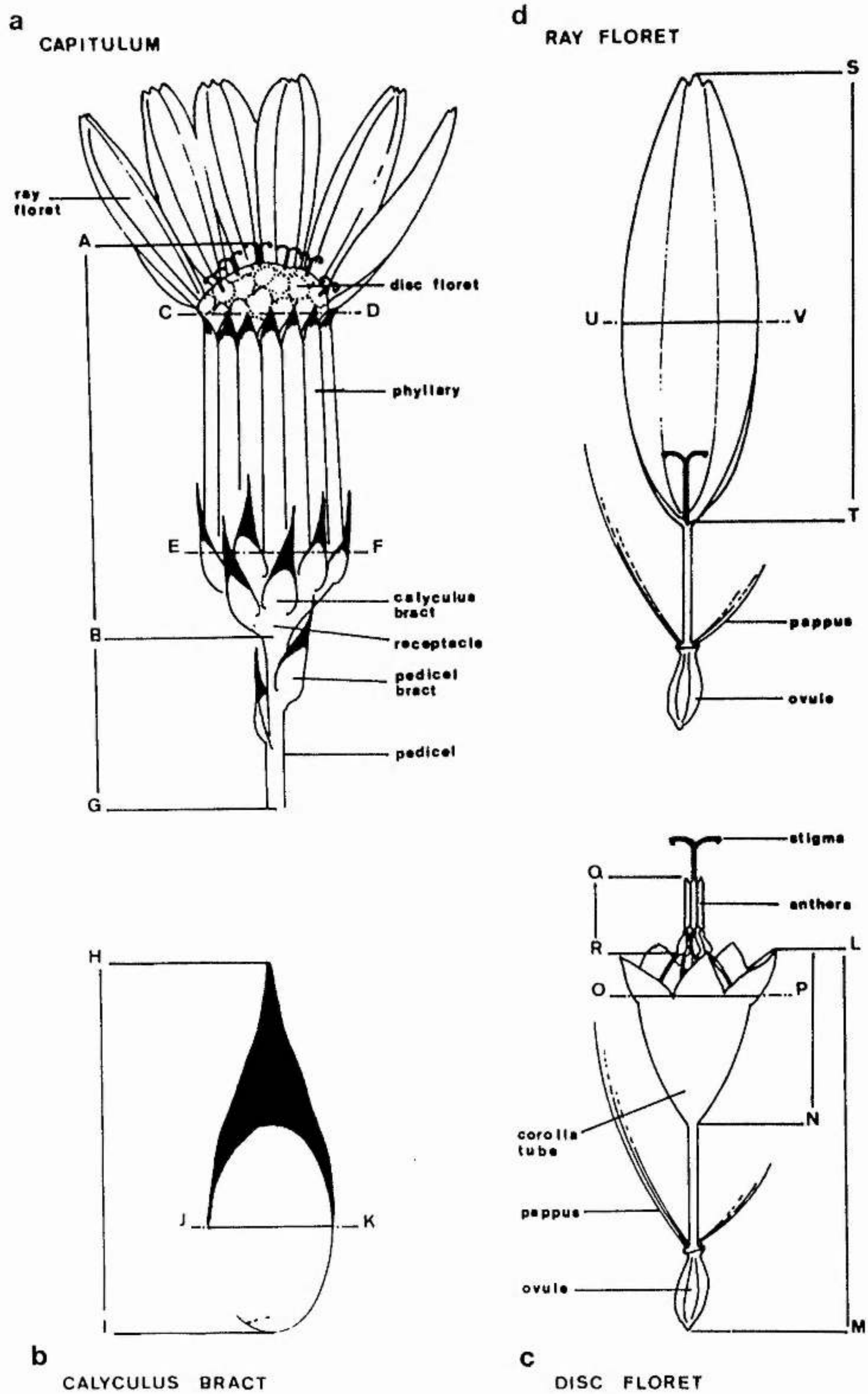


FIGURE 5.3.2 Drawing of the apical capitulum of S. vulgaris var. hibernicus showing (a) the capitulum size and shape characters C35 to C38, (b) the calyculus bract characters C49 to C52, (c) the disc floret characters C54 to C57, and (d) the outer (ray) floret characters C59 to C61.

C33 MLF Basal Angle B.

The angle between the base of the primary vein and the apices of the adjacent basal lobes on either side of the primary vein. Angle IFJ in Figure 5.3.1b.

C34 MLF Secondary Vein Angle.

Defined as the angle between the Mid-Lobe secondary vein and the primary vein. Angle KLM in Figure 5.3.1b.

C35 Capitulum Total Length.

Defined as the length from the point at which the pedicel widens into the receptacle to the stigmatic surface of the central disc floret. Length AB in Figure 5.3.2a.

C36 Capitulum Apex Width.

Diameter of the capitulum, measured at the level of the outermost ring of disc florets. Length CD in Figure 5.3.2a.

C37 Capitulum Base Width.

Diameter of the capitulum measured at the level of the base of the phyllaries. Length EF in Figure 5.3.2a.

C38 Pedicel Length.

maximum length of the pedicel from the apical stem node to the point at which the pedicel widens into the receptacle.

C39 Number of Phyllaries.

C40 Maximum Phyllary Length.

Defined as the length of the longest phyllary.

C41 Proportion of Phyllaries with Black Tips.

Defined as the number of phyllaries with black and/or brown tips divided by the total number of phyllaries.

C42 Max Phyllary Hair Density.

Defined as the maximum number of non-glandular trichomes occurring on any single phyllary.

C43 Max Phyllary Gland Density.

Defined as the maximum number of glandular trichomes occurring on any any single phyllary,

C44 Number of Calyculus Bracts.

Total number of bracts which are attached to the receptacle, i.e. bracts occuring above point B in Figure 5.3.2a.

C45 Number of Pedicel Bracts.

Total number of bracts which are attached to the pedicel, i.e., bracts occurring below between points B and E in Figure 5.3.2a.

C46 Mean Calyculus Bract Hair Density.

Mean number of non-glandular trichomes per calyculus bract, defined as the total number of hairs on the calyculus bracts divided by the number of calyculus bracts.

C47 Mean Calyculus Bract Gland Density.

Defined as C46, except for glandular trichomes instead of non-glandular trichomes.

C48 Mean Calyculus Bract Length.

Defined as the sum of the lengths of the calyculus bracts, length HI in figure 5.3.2b, divided by the number of calyculus bracts.

C49 Range of Calyculus Bract Length.

Defined as the difference between the maximum and the minimum calyculus bract lengths.

C50 Mean Calyculus Bract Width.

Defined as the sum of the maximum calyculus bract widths (JK in Figure 5.3.2b) divided by the number of calyculus bracts.

C51 Calyculus Bract Max Black Tip Length.

Length of the longest black tip on the calyculus. Length JH in figure 5.3.2b

C52 Calyculus Bract Max Black Tip Width.

Width of the widest black tip on the calyculus. Length JK in Figure 5.3.2b.

C53 Number of Disc Florets.

C54 Mean Disc Floret Total Length.

Defined as the length from the base of the ovule to the apex of the corolla tube lobes. Length ML in Figure 5.3.2c. Mean of a sample of 10 disc florets from the centre of the capitulum.

C55 Mean Disc Floret Corolla Length.

Length from the base of the corolla, defined as the point of attachment of the stamens, to the apex of the corolla lobes. Length NL in Figure 5.3.2c. Mean of a sample of 10 disc florets used in C54.

C56 Mean Disc Floret Corolla Width.

Defined as half the circumference of the corolla tube, measured at the base of the corolla lobes. Length OP in figure 5.3.2c. Mean of the sample of 10 florets used in C45 and C55.

C57 Max Disc Floret Anther Length.

Maximum length from the base of the 'knees' tc the apex of of the anthers. Length RO in Figure 5.3.2c.

C58 Number of Ray Florets.

C59 Mean Cuter Floret Length.

Sum of the lengths of the outer florets, defined as the length from the point of attachment of the stamens to the apex of the ligule divided by the number of outer florets. Length TS in Figure 5.3.2d.

C60 Range of Outer Floret Length.

Defined as being the difference between the maximum and the minimum outer floret lengths.

C61 Mean Cuter Floret Width.

Sum of the maximum widths of the outer florets divided by the number of cuter florets. Length UV in Figure 5.3.2d.

C62 Cuter Floret Ray Gland Density.

Sum of the number of glandular trichomes above below the point of attachment of the stamens over the number of outer florets.

C63 Cuter Floret Tube Gland Density.

Mean number of glands occurring between the apex of the ovule and the point of attachment of the stamens cn the outer florets.

C64 Cuter Floret Anther Development.

Defined as a multistate character, the states and codes being:

a. complete absence of stamens and filaments. 0

b. 1 or 2 short filaments. 1

c. 3 to 5 short filaments. 2

d. 5 normal length filaments. 3

e. 5 normal length filaments plus some development of 1 or 2 anthers. 4

f. 5 normal length filaments plus some development of 3 to 5 anthers. 5

g. full development of 5 anthers, anthers fused. 6

5.4 Assessment of the character set.

As discussed in section 4, the choice of the character set to be used in any numerical study is dependent on the purpose of the study. Maximizing the number of characters is not necessarily the best strategy (Bisby, 1970, 1977), particularly if the characters are incongruent, as is frequently found when different types of characters, e.g., biochemical and morphological, are used. In this study, in that it was an examination of possible introgression between a group of closely related taxa at the population level using only morphometric data, the choice of the character set was based on maximizing the number of non-redundant characters. Characters were considered to be redundant if (a) they did not distingish at least one of the species or varieties, or (b) they were correlated with other characters such that they cou ld not be considered independent unit characters.

Assessment of the 64-character set given in section 5.3 was done using the 23 purebred species lines. The hybrid lines were excluded from these initial analyses, in that the purpose of this initial series of analyses was to determine the optimal character set to distinguish Senecio species.

All computations in this section were carried out using the SPSS statistical package on a VAX 11 computer.

5.4.1 Univariate analysis of the character set.

The results of oneway analysis of variance of each of the 63 continuous characters is given in table 5.4.1, together with the results of 3 tests of homogeneity of variances; Cochran´s C, Bartlett Box F, and the maximum variance : minumum variance ratio.

All 63 characters had F ratios which gave probabilities (p) of less than 0.0001, that is all 63 characters had F ratios which were statistically highly significant. The capitular characters in general were found to have F ratios greater than those of the vegetative characters. In particular the indumentum characters C42 (Max Phyllary Hair Density), C43 (Max Phyllary Gland Density), C46 (Mean Calyculus Bract Hair Density), and C47 (Mean Calyculus Bract Gland Density) had F ratios much greater than the other characters

It was also found that the disc floret characters C55 (Mean Disc Floret Corolla Width), C56 Mean Disc Floret Corolla Length), and C57 (Max Disc Floret Anther Length), had F ratios greater than those of the outer floret characters C58 (Number of Ray Florets) and C59 (Mean Outer Floret Length)

	CHARACTER	F-ratio	p.	Cochran's c.	p.	Bartlett Box F	p.	Maximum/ minimum variance
C01	Days to Flowering	153.807	0.0000	0.6622	0.000	34.957	0.000	145.603
C02	Plant Height	45.607	0.0000	0.3680	0.000	22.995	0.000	22.755
C03	Inflorescence Length	112.478	0.0000	0.5464	0.000	31.755	0.000	21.897
C04	Number of Internodes	134.253	0.0000	0.3292	0.000	7.998	0.000	17.591
C05	Basal Stem Diameter	42.608	0.0000	0.3079	0.000	5.111	0.000	4.338
C06	Number of Leaves	22.455	0.0000	0.3835	0.000	17.306	0.000	14.240
C07	Propn. Laterals with Capitula	119.798	0.0000	0.6090	0.000	32.457	0.000	74.495
C08	Longest Leaf Length	18.422	0.0000	0.3099	0.000	10.108	0.000	20.375
C09	Midleaf Length	33.924	0.0000	0.4660	0.000	15.967	0.000	432.342
C10	MLF Max Width R.	39.374	0.0000	0.4709	0.000	23.144	0.000	718.279
C11	MLF Max Width L.	39.081	0.0000	0.5185	0.000	24.313	0.000	72.088
C12	MLF Base to Max Width R.	25.310	0.0000	0.2672	0.000	5.243	0.000	50.774
C13	MLF Base to Max Width L.	24.038	0.0000	0.2878	0.000	5.483	0.000	124.362
C14	MLF Auricle Length	34.524	0.0000	0.3685	0.000	17.372	0.000	230.479
C15	MLF Auricle Width	35.346	0.0000	0.3498	0.000	20.347	0.000	398.892
C16	MLF Number of Lobes	62.701	0.0000	0.2636	0.000	3.589	0.001	3.748
C17	MLF Apical Lobe Length	49.349	0.0000	0.5034	0.000	19.770	0.000	688.830
C18	MLF Apical Lobe Width	29.644	0.0000	0.3329	0.000	8.876	0.000	37.535
C19	MLF Longest Lobe Length	50.552	0.0000	0.4620	0.000	20.840	0.000	907.918
C20	MLF Mid-lobe Length	53.915	0.0000	0.4853	0.000	20.301	0.000	36.919
C21	MLF Mid-lobe Max Width A.	45.711	0.0000	0.3007	0.000	9.138	0.000	20.127
C22	MLF Mid-lobe PV to Max Width A.	49.403	0.0000	0.4043	0.000	22.766	0.000	24.938
C23	MLF Mid-lobe Max Width B.	28.268	0.0000	0.5079	0.000	24.437	0.000	29.061
C24	MLF Mid-lobe PV to Max Width B.	30.418	0.0000	0.3577	0.000	11.820	0.000	42.151
C25	MLF Mid-lobe Apical Width	60.483	0.0000	0.2721	0.000	8.033	0.000	10.273

TABLE 5.4.1 results of oneway analyses of variance and tests of hcmogeneity of variances cf the 63 continuous characters

	CHARACTER	F-ratio	p.	Cochran's c.	p.	Bartlett Box F	p.	Maximum/ minimum variance
C26	MLF Mid-lobe Basal Width	89.778	0.0000	0.3668	0.000	8.559	0.000	25.753
C27	MLF Mid-lobe Lamina Width	47.397	0.0000	0.4795	0.000	14.782	0.000	56.071
C28	MLF Internode Length A.	13.798	0.0000	0.4801	0.000	20.841	0.000	352.198
C29	MLF Internode Length B.	22.628	0.0000	0.3195	0.000	8.819	0.000	51.110
C30	MLF Apical Angle A.	39.111	0.0000	0.2683	0.000	4.319	0.000	18.184
C31	MLF Apical Angle B.	22.903	0.0000	0.2658	0.000	6.202	0.000	7.523
C32	MLF Basal Angle A.	40.331	0.0000	0.2784	0.000	8.269	0.000	141.031
C33	MLF Basal Angle B.	15.141	0.0000	0.5273	0.000	19.848	0.000	516.299
C34	MLF Secondary Vein Angle	17.814	0.0000	0.2735	0.000	4.928	0.000	40.112
C35	Capitulum Total Length	165.157	0.0000	0.1763	0.000	2.235	0.243	2.567
C36	Capitulum Apex Width	445.722	0.0000	0.6253	0.000	44.784	0.000	126.568
C37	Capitulum Base Width	188.054	0.0000	0.3097	0.000	7.235	0.000	6.595
C38	Pediclel Length	48.376	0.0000	0.3989	0.000	22.249	0.000	21.916
C39	Number of Phyllaries	34.785	0.0000	0.4298	0.000	22.916	0.000	89.583
C40	Max Phyllary Length	54.360	0.0000	0.2230	0.000	3.635	0.001	29.180
C41	Propn. Phyllaries with Black Tips	16.565	0.0000	0.2694	0.000	3.186	0.005	3.186
C42	Max Phyllary Hair Density	1057.920	0.0000	0.9247	0.000	103.102	0.000	796.781
C43	Max Phyllary Gland Density	1712.470	0.0000	0.6550	0.000	64.407	0.000	292.105
C44	Number of Calyculus Bracts	81.345	0.0000	0.2440	0.000	6.557	0.000	44.875
C45	Number of Pedicel Bracts	17.966	0.0000	0.5536	0.000	44.256	0.000	71.568
C46	Mean Calyc. Bract Hair Density	490.570	0.0000	0.3689	0.000	115.643	0.000	1475.250
C47	Mean Calyc. Bract Gland Density	5587.811	0.0000	0.8731	0.000	124.571	0.000	4444.542
C48	Mean Calyc. Bract Length	80.347	0.0000	0.2860	0.000	7.079	0.000	13.219
C49	Range Calyc. Bract Length	11.320	0.0000	0.3122	0.000	12.300	0.000	66.036
C50	Mean Calyc. Bract Width	82.083	0.0000	0.3196	0.000	7.416	0.000	17.596

TABLE 5.4.1 continued.

	CHARACTER	F-ratio	p.	Cochran's c.	p.	Bartlett Box F	p.	Maximum/ minimum variance
C51	Calyc. Bract Max Black Tip Length	16.182	0.0000	0.5851	0.000	27.950	0.000	113.285
C52	Calyc. Bract Max Black Tip Width	67.533	0.0000	0.2732	0.000	8.303	0.000	19.871
C53	Number of Disc Florets	103.165	0.0000	0.4087	0.000	24.535	0.000	72.621
C54	Mean Disc Floret Total Length	153.787	0.0000	0.2015	0.031	3.938	0.000	3.399
C55	Mean Disc Floret Corolla Length	620.377	0.0000	0.3083	0.000	10.626	0.000	26.366
C56	Mean Disc Floret Corolla Width	956.173	0.0000	0.2940	0.000	10.085	0.000	10.500
C57	Max Disc Floret Anther Length	1154.441	0.0000	0.3245	0.000	15.637	0.000	19.926
C58	Number of Ray Florets	210.848	0.0000	0.3943	0.000	13.292	0.000	124.087
C59	Mean Outer Floret Length	201.913	0.0000	0.6327	0.000	115.501	0.000	1515.244
C60	Range OUter Floret Length	48.076	0.0000	0.6777	0.000	62.408	0.000	123.972
C61	Mean Outer Floret Width	368.780	0.0000	0.5836	0.000	61.456	0.000	212.775
C62	Outer Floret Ray Gland Density	63.495	0.0000	0.3739	0.000	40.519	0.000	283.838
C63	Outer Floret Tube Gland Density	80.996	0.0000	0.7706	0.000	158.428	0.000	1505.141
C64	Outer Floret Anther Development	-	-	-	-	-	-	-

TABLE 5.4.1 continued.

Therefore on the basis of the one-way analyses of variance all 63 continuous characters are non-redundant in that all show statistically significant differences between species. However, characters may also be redundant because they are highly correlated, and therefore the correlations of the characters were also examined.

5.4.2 Character correlation.

The interdependence of characters can be considered in terms of the way in which the characters have been formulated. Logical correlation as defined by Sneath & Sokal (1973) is where the definitions of two characters are tautological. Logical correlation as defined by Jardine & Sison (1970) is where an attribute is conditionally defined on the state of another attribute, e.g., conditionally present characters.

The interdependence of characters can also be considered in terms of their common genetic control, i.e., pleiotropy and linkage. Genetic covariance is the sum of the additive, dominace, and epistatic covariances plus higher order interactions; and it has been shown that eigenanalysis of additive genetic correlation matrices tend to give a general pleiotropic or genetic size function as the largest component of genetic covariance (Atchley, Rutledge, & Cowley, 1981).

Figure 5.4.1 shows the pooled within groups correlation matrix of the 64 characters. The pooled within-groups correlation was used rather than the product-moment correlation as it has the effect of removing the intraspecific correlation. From this figure it can be seen than characters C08 (Longest Leaf Length), C09 (Midleaf Length), C10 (MLF Max Width R), C11 (MLF Max Width L), C12 (MLF Base to Max Width R), C13 (MLF Base to Max Width L), C17 (MLF Apical Lobe Length), C18 (MLF Apical Lobe Width), C19 (MLF Longest Lobe Length), C20 (MLF Mid-Lobe Length), C21 (MLF Mid-Lobe Max Width A), C23 (MLF Mid-Lobe Max Width B), C28 (MLF Intercostal Length A), and C29 (MLF Intercostal Length B) account for almost all of the high positive correlations.

The only character pair which was found to have a high negative correlation was C59 (Mean Outer Floret Length) and C64 (Outer Floret Anther Development). As previously discussed in section 5.1, character C64 is linked to, or is a plieotropic effect of character C59.

This suggests that there is a simple size difference between the leaves of the species, rather than a difference in leaf shape, and therefore that the majority of the mid-leaf characters are redundant in that they are multiple measurement of a single unit character, leaf size.

The technique most commonly used to remove size effect in describing biological shapes such as leaves is to express the characters as ratios, e.g., Hickey (1973), Blackburn (1978), Hill (1980). However, Atchley, Gaskins & Anderson (1976) have argued that there are statistical problems associated with the the use of ratios. The distribution of ratios is not normal, and is more skewed and leptokurtic than the distribution of the original variables. They also argue that ratios will not standardize for size as there is relatively high correlation between the ratio and the size variable. Jensen (1977) in comparing two data sets of Quercus, one of which included a high proportion of ratios, the other the untransformed variables, did not find the expected increase in the first eigenvalue due to increased character correlation. Instead there was a mean decrease in the first eigenvalue from 7.46 to 5.04, and a decrease in the mean correlation from 0.284 in the untransformed data set to 0.110 in the ratio data set. However, Jensen did not use a single common denominator, whereas Atchley et. al. (1976) did. Dodson (1978) and Hills (1978) have also disputed the findings of Atchley et. al. (1976), but these arguments have been rebutted by Atchley & Anderson (1978). Thorpe (1983) points out that ratios are an acceptable method of adjusting for size only if the relationship between the two variables is linear and passes through the origin. Therefore, as isometric growth is the exception rather than the rule, ratios are not an appropriate method, and consideration of the statistical properties of ratios and their minor effects on correlation is irrelevant.

However, the problem with removing characters on the basis of their correlation with other characters is that there is no defined criterion for deciding the level of correlation which consitutes redundancy. Although characters C59 (Mean Outer Floret Length) and C64 (Outer Floret Anther Development) are very highly correlated, as can be seen from Figure 5.4.2, there is still a residual information component, in that C64 separates the ray floret lengths of *S. vulgaris* var. *hibernicus* and *S. viscosus*. That is, although characters C59 and C64 are statistically correlated, they are not concordant, as defined by Jardine & Sibson (1971), in all species and therefore cannot be considered redundant.

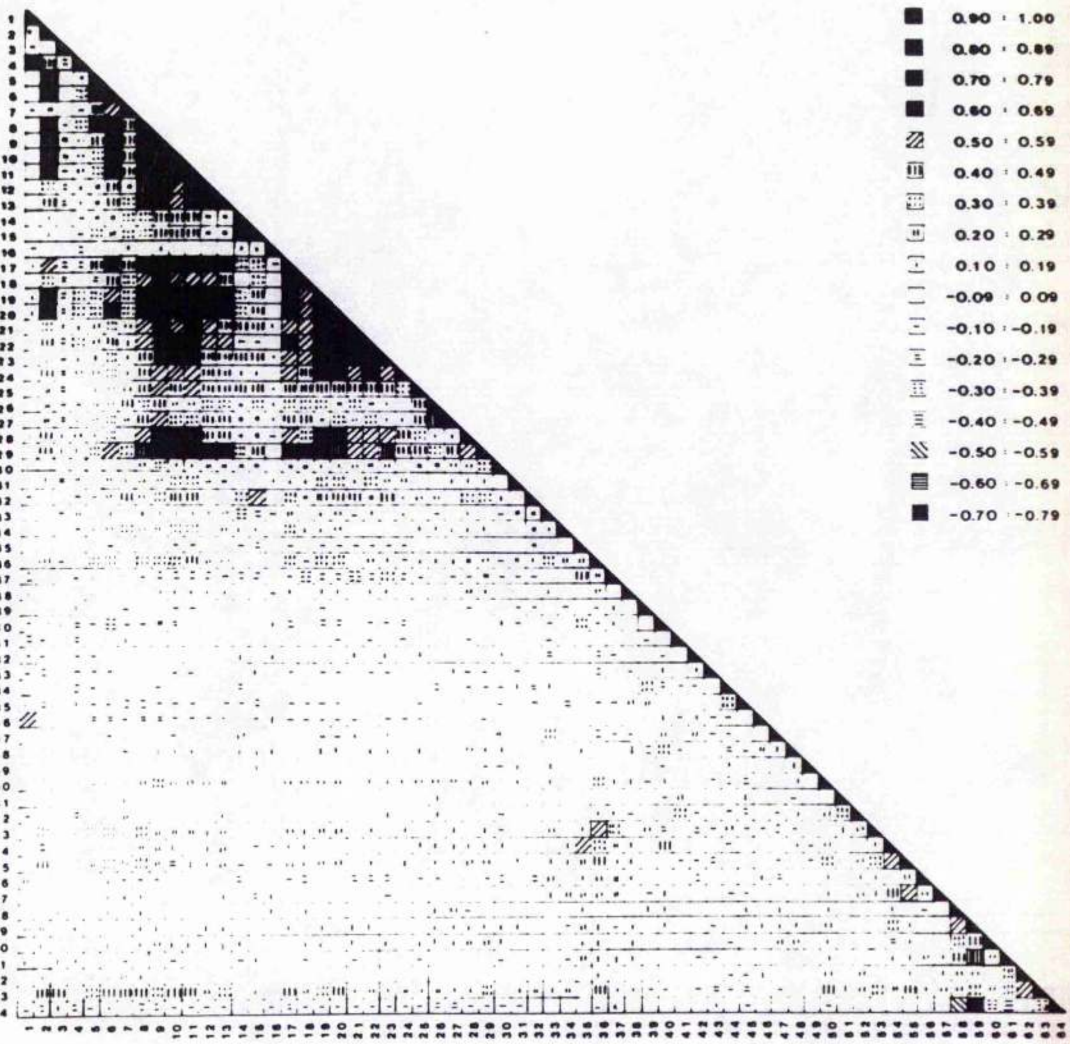


FIGURE 5.4.1 Matrix of the pocled within-groups character correlations of the 64-characters set. The grcups were the eight species and varieties, S. vulgaris var. vulgaris, S. vulgaris var. hibernicus, S. vulgaris var. denticulatus, S. squalidus, S. cambrensis, S. viscosus, S. sylvaticus, and S. vernalis.

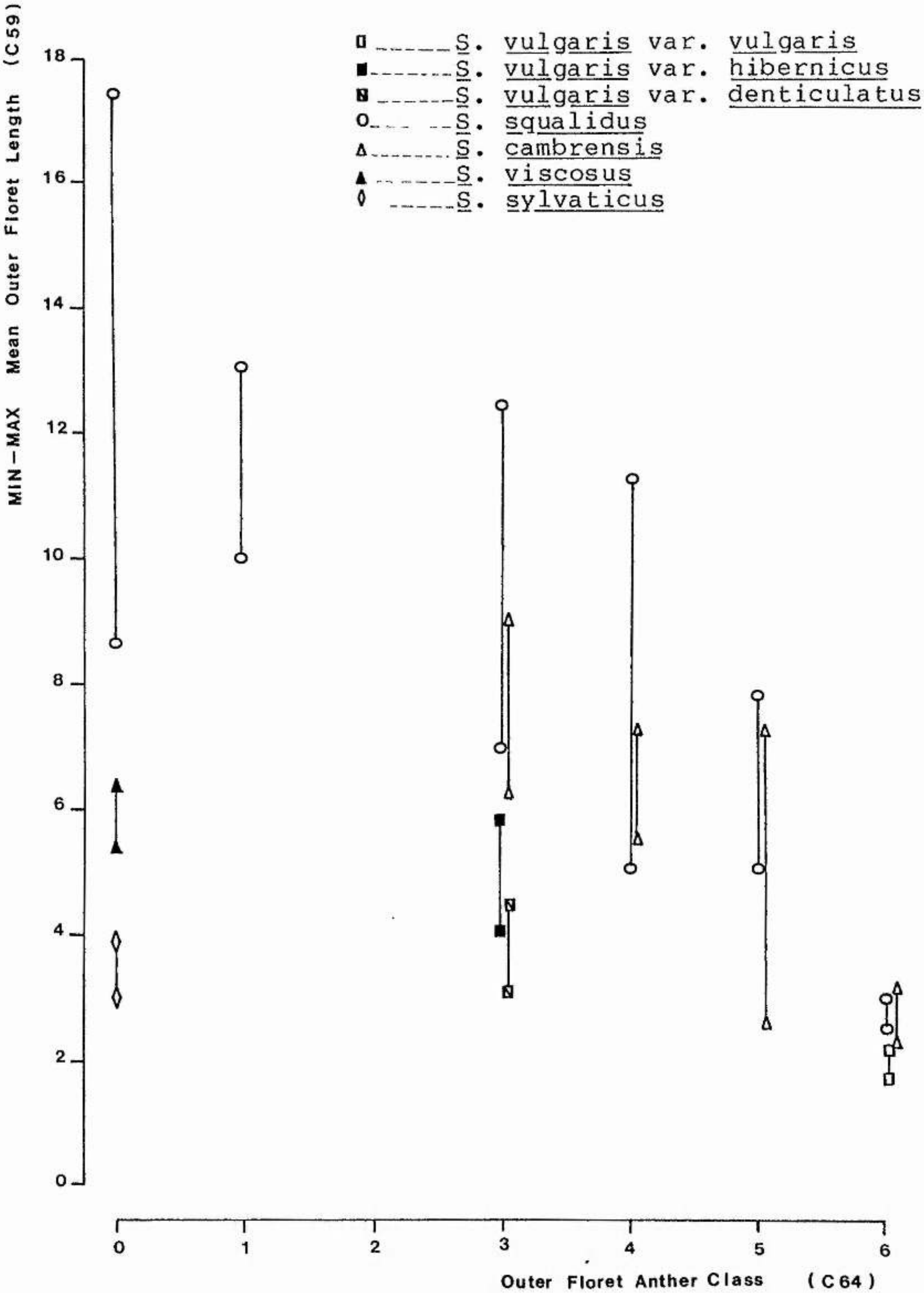


FIGURE 5.4.2 Illustrating the high negative correlation between characters C59 (Mean Outer Floret Length) and C64 (Outer Floret Anther Class) in the polymorphic species S. vulgaris, S. squalidus, and S. cambrensis; and the non-concordance of the monomorphic species, S. viscosus and S. sylvaticus, with this correlation.

5.4.3 Discriminant function analysis.

In addition to being used as an ordination method, discriminant function analysis can be used to determine the relative importance of the characters as discriminators between the predefined groups. A stepwise selection procedure can be used to determine the optimal character set on the basis of a number of criteria, such as minimizing Wilk´s lambda, or maximizing Mahalonobis D or Rao´s V. The relative importance of the discriminant functions is indicated by the magnitude of the eigenvalues, the percentage of variance for which the function accounts, and the canonical correlation of the function. The relative contributions of the characters to each function is shown by the relative magnitude of the standardized discriminant function coefficients.

Discriminant function analysis of the 64-character set was computed using the SPSS statistical package subprogram DISCRIMINANT. The predefined groups were the eight species and varieties; S. vulgaris var. vulgaris, S. vulgaris var. hibernicus, S. vulgaris var. denticulatus, S. squalidus, S. cambrensis, S. viscosus, S. sylvaticus, and S. vernalis. The stepwise method used was RAO, which maximizes Rao´s V.

The eigenvalues, percentages of variance, cumulative percentages of variance, and canonical correlations of the seven discriminant functions computed are given in Table 5.4.2.

TABLE 5.4.2 Eigenvalues, percentages of variance, cumulative percentages of variance, and canonical correlations of the 7 discriminant functions.

Function	Eigenvalue	% of variance	Cumulative %	Canonical correlation
1	213.9938	53.82	53.82	0.9976
2	89.1554	22.42	76.24	0.9944
3	60.5030	15.22	91.46	0.9918
4	15.8456	3.99	95.44	0.9698
5	12.0001	3.02	98.46	0.9607
6	3.4398	0.87	99.33	0.8802
7	2.6762	0.67	100.00	0.8532

The stepwise procedure excluded 8 of the 64 characters from the analysis: character C09 (Midleaf Length), C11 (MLF Max Width L), C12 (MLF Base to Max Width R), C13 (MLF Base to Max Width L), C22 (MLF Mid-Lobe PV to Max Width A), C32 (MLF Basal Angle A), C33 (MLF Basal Angle B), and C49 (Range Calyculus Bract Length).

When the group centroid scores were examined it was found that _S. viscosus_ had a pathologically large score on the first discriminant function, having a mean score of 80.071 as compared with scores of between -6.821 and 2.615 for the other groups. _S. sylvaticus_ has a similarly high score on the third function, with a mean value of 42.313 as compared with values between -5.169 and 1.154 for the other 7 groups. From the standardized coefficients it was apparent that this was due to the extremely high contribution of the four indumentum characters C42, C43, C46 and C47 to the first and third functions.

The four indumentum characters were transformed to square roots, giving the characters C421 (SQRT Max

Phyllary Hair Density), C431 (SQRT Max Phyllary Gland Density), C461 (SQRT Mean Calyculus Bract Hair Density), and C471 (SQRT Mean Calyculus Bract Gland Density). Logarithms were not used because the resultant negative numbers prevented resolution of the eigenproblem.

Four of the midleaf characters which had been excluded by the stepwise method were redefined. Characters C10 and C11 were summed to give character C101 (MLF Total Max Width), and characters C12 and C13 were averaged to give character C121 (MLF Mean Base to Max Width).

The 62-character set was reanalysed using the same method as the previous discriminant function analysis, except that the predefined groups were taken as the 23 species lines; S. vulgaris var. vulgaris lines 11 - 16, S. vulgaris var. hibernicus lines 21 - 23, S. vulgaris var. denticulatus lines 31 - 32, S. squalidus lines 41 - 46, S. cambrensis lines 51 - 52, S. viscosus line 61, S. sylvaticus line 71, and S. vernalis line 81.

The eigenvalues. percentages of variance, cumulative pecentages of variance and the canonical correlations of the first ten of the 22 discriminant functions computed are given in Table 5.4.3.

The relative contribution of the indumentum characters has been reduced, although characters C461 (SQRT Mean Calyculus Bract Hair Density) and C471 (SQRT Mean Calyculus Bract Gland Density) still had the third and fourth largest standardized coefficients on the second

TABLE 5.4.3 Eigenvalues, percentages of variance, cumulative percentages of variance, and canonical correlations of the first ten discriminant functions.

function	eigenvalue	% of variance	cumulative %	canonical correlation
1	164.36221	44.74	44.74	0.9969717
2	79.57922	21.66	66.41	0.9937756
3	51.77010	14.09	80.50	0.9904796
4	20.55890	5.60	86.10	0.9765324
5	15.75512	4.29	90.39	0.9696993
6	5.99007	1.63	92.02	0.9257105
7	5.58101	1.52	93.54	0.9208950
8	4.34138	1.18	94.72	0.9015446
9	3.97239	1.08	95.80	0.8938061
10	3.28708	0.89	96.69	0.8756375

TABLE 5.4.5 Canonical discriminant functions evaluated at group means (group centroids).

GROUP	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
11	-12.28286	4.44560	0.48282	-2.19647	1.99134
12	-11.46964	5.94395	1.04399	-2.20062	-2.42283
13	-12.75629	6.53387	0.59119	-2.77225	-2.68785
14	-12.81946	6.74928	2.29786	-2.56739	-0.96156
15	-12.29958	5.94968	1.74642	-1.55870	-1.39457
16	-12.44927	2.62104	-2.11254	-2.03050	-3.21248
17	-11.44625	2.34916	0.60331	-4.17064	-3.63375
21	-11.94165	4.32932	2.67772	-1.23748	-0.16795
22	-8.29988	-0.75715	0.43137	1.54617	-0.80828
23	-7.73633	3.60260	2.14828	-1.62089	1.77652
31	-7.94543	-7.29175	-1.62120	6.41216	-2.15103
32	-7.23569	-9.95092	-5.29488	10.41165	-2.48311
41	18.16274	2.64054	-3.35361	-0.02012	2.35741
42	13.55802	-1.84385	0.97465	-3.06492	3.00338
43	15.45536	0.71620	-2.25641	-3.14172	-2.00623
44	15.02906	2.20691	-0.52212	-1.15743	-1.18080
45	15.18150	-0.50242	0.92522	-2.05598	-1.37076
46	19.85994	2.74619	-3.93455	0.83233	-3.55757
51	1.99631	7.21581	0.97955	4.03321	9.73979
52	3.00654	5.63940	2.33067	4.43224	8.61124
61	4.72037	-26.86506	31.93880	-1.45113	-0.71356
71	-12.37703	-29.21339	-19.05873	-11.33917	6.80471
81	7.07446	-13.83143	-14.60033	-1.35585	-1.0700

TABLE 5.4.4 Standardized canonical discriminant function coefficients.

	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
C01	0.08208	0.13332	0.05631	0.88945	-0.10138
C02	-0.01379	-0.14540	-0.22349	-0.00073	0.01321
C03	0.12420	-0.23744	0.15506	-0.29880	0.11188
C04	-0.08924	-0.56200	-0.32757	-0.27151	-0.05117
C05	-0.03510	-0.21851	-0.25366	-0.13723	0.38993
C06	-0.08514	-0.15533	-0.23846	0.42034	-0.61979
C07	-0.45057	0.05330	0.24465	-0.30567	0.30206
C08	0.08612	0.13124	-0.05677	0.37656	0.05325
C09	0.01843	-0.02815	-0.43969	-0.11248	0.01730
C101	0.11866	0.12756	0.71314	-0.37019	0.91621
C121	0.03444	0.06752	0.21680	-0.25600	-0.01752
C14	0.06058	-0.02268	0.13260	-0.13959	0.05789
C15	-0.27199	0.09333	-0.05532	0.18761	0.13392
C16	-0.10098	-0.11809	0.11378	-0.32822	-0.14946
C17	0.22365	-0.04994	-0.13272	-0.18494	-0.22097
C18	-0.07968	0.05302	0.11999	-0.22195	0.26347
C19	-0.16884	0.06793	-0.23573	0.61960	-0.05491
C20	0.25182	0.19315	0.16268	-0.22936	-0.13798
C21	-0.13649	-0.01164	-0.08020	-0.40549	-0.07549
C23	0.06437	-0.10400	-0.02053	0.31910	0.40630
C24	0.10330	0.14031	-0.01533	0.35313	0.06087
C25	0.14290	0.04640	-0.10383	0.00704	0.04390
C26	-0.03449	0.05923	0.07027	0.32201	0.00260
C27	-0.09383	0.14474	-0.03583	-0.15802	-0.03488
C28	-0.10346	-0.02665	-0.01935	-0.01706	-0.51119
C29	0.10275	-0.02184	0.05901	0.03440	-0.26988
C30	0.19753	0.01703	-0.13682	-0.04597	-0.16738
C31	0.02619	0.12755	0.14688	0.06610	0.09849
C33	0.09294	0.04124	0.09875	0.14782	-0.10990
C34	0.11798	-0.04946	0.00488	0.21916	-0.12830
C35	0.04285	0.11146	0.05213	0.12466	-0.07056
C36	0.12656	0.14962	-0.16015	-0.27627	-0.41673
C37	0.19910	0.01095	0.28658	0.17268	0.19789
C38	-0.00328	-0.03493	0.07449	0.05665	0.16320
C39	0.05151	0.14991	0.04164	-0.04802	-0.04736
C40	-0.20727	-0.03792	-0.11035	0.01145	0.29756
C41	0.05436	0.02069	0.13430	0.16105	-0.01068
C421	0.04075	-0.17149	-0.39773	-0.38868	0.32932
C431	0.20535	-0.41665	0.16718	-0.09938	0.06318
C44	-0.38017	0.15042	0.13495	0.28760	0.08592
C45	0.15217	-0.05752	0.20093	-0.45412	-0.09803
C461	-0.19056	-0.52116	-0.70714	0.05351	0.08909
C471	0.00073	-0.45734	0.91068	0.02882	-0.24726
C48	0.21677	0.17899	0.25175	0.02571	0.29772
C49	-0.01381	-0.04687	-0.08229	0.00345	-0.03406
C50	-0.05455	0.04254	-0.09669	0.21154	0.08075
C51	0.11474	0.20245	0.06281	0.28198	0.15231
C52	-0.11865	0.11248	0.18136	-0.07468	-0.06701
C53	0.28989	-0.20776	-0.02267	-0.02269	0.02419
C54	-0.42794	-0.13446	-0.19056	0.37359	0.05120
C55	0.54777	-0.00518	-0.02049	0.29443	0.13991
C56	0.48189	0.08146	-0.10824	-0.19665	-0.31144
C57	0.47550	-0.06402	-0.00113	-0.01934	0.42144
C58	0.08262	-0.20238	0.10424	0.43659	0.23344
C59	0.24516	0.56463	0.26043	-0.00704	-0.15323
C60	-0.10426	0.01883	-0.23457	-0.10317	0.09157
C61	0.15876	0.18540	-0.18397	-0.09861	0.07076
C62	-0.09601	-0.11236	0.10942	-0.16554	0.29013
C63	-0.03319	0.05449	-0.39528	-0.08283	-1.06090
C64	-0.13945	0.73296	0.10100	0.20030	-0.36337

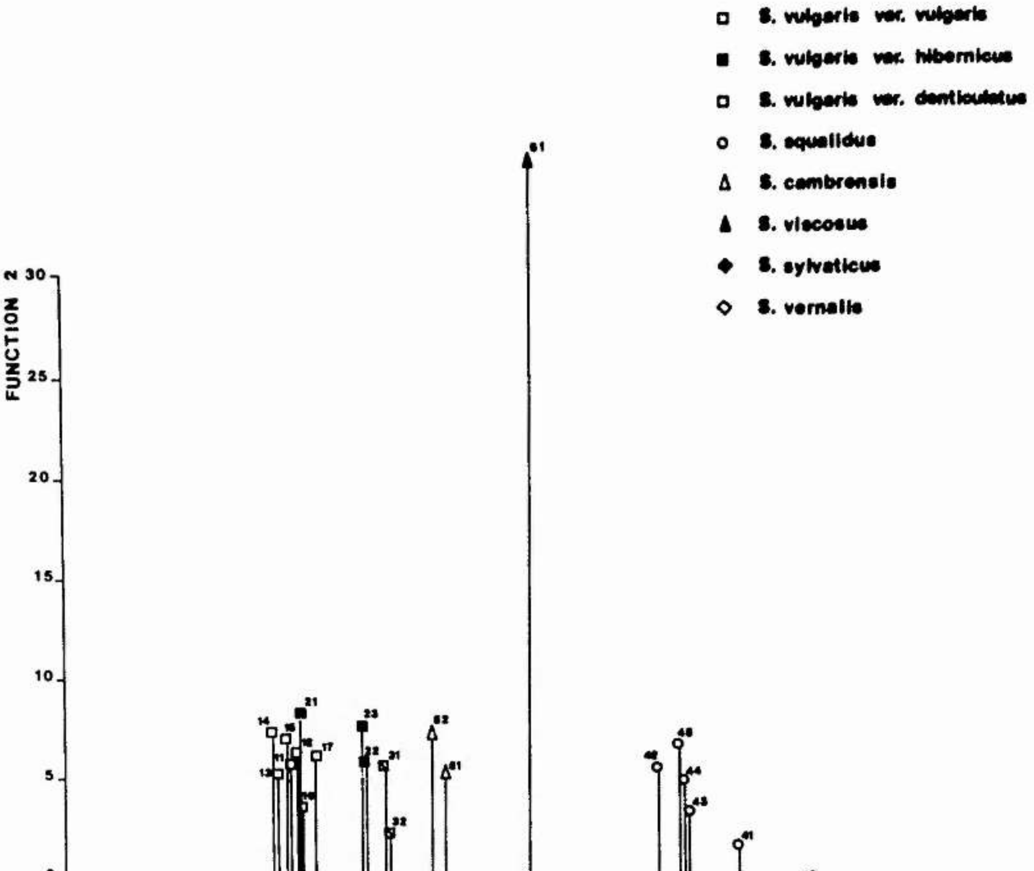


FIGURE 5.4.2 Group centroids of the 23 pure species lines plotted against the first three discriminant functions using the 61 character set.

function, and the largest standardized coefficients on the third function.

Figure 5.4.2 shows a plot of the groups centroids of the 23 species lines against the first three discriminant functions. The first function discriminates between the species with large capitulua, S. squalidus and S. vernalis, and the species with small capitulum, S. vulgaris and S. sylvaticus, with S. viscosus and S. cambrensis intermediate. The characters with the largest standardized coefficients on this function were C55 (Mean Disc Floret Corolla Length) at 0.54776, C56 (Mean Disc Floret Corolla Width) at 0.47895, and C57 (Max Disc Floret Anther Length) at 0.47743. The characters with the highest standardized coefficients on the second discriminant function were characters C64 (Outer Floret Anther Development) at -0.63383, C04 (Number of Internodes) at 0.54702, C461 (SQRT Mean Calyculus Bract Hair Density) at 0.50965, and C471 (SQRT Mean Calyculus Bract Gland Density) at 0.50080. Characters C461 and C471 also had the highest standardized coefficients on the third function at -0.74447 and 0.87629 respectively.

Therefore, the ordination obtained in this second discriminant function analysis, as shown in Figure 5.4.2, conforms well with the 'known' model of the relationships in the British Senecio species. The first function separates the diploids with large capiltula and large ray florets from the the tetraploids with small capitula, and small or absent ray florets. tetraploids. The second function separates the slower-growing, rosette forming groups *S. vulgaris* var. *denticulatus*, *S. viscosus*, *S. sylvaticus*, and *S. vernalis*, from *S. vulgaris* var. *hibernicus*, *S. vulgaris* var. *vulgaris*, and *S. squalidus*. The third function separates the species on the basis of indumentum, separating the viscid glandular *S. viscosus*, and the floccose *S. sylvaticus*, from the subglabrous *S. vulgaris* and *S. squalidus*. Equally the ordination reflects the 'known' model in that *S. vulgaris* var. *hibernicus* is distinct from *S. vulgaris* var. *vulgaris* and varies in the direction of *S. squalidus*, and that *S. cambrensis* is intermediate between *S. vulgaris* var. *vulgaris* and *S. squalidus*.

5.5 The final character set.

The final character set, therefore was taken as the 61 characters which were included in the discriminant function analysis by the stepwise method. Although some of these characters were statistically correlated, as discussed in section 5.4.2, they still contributed to the discrimination of the species, and therefore must be considered to have a useful information content.

The usefulness of this character set in discriminating between the lines, varieties and species of Senecio may be assessed additionally be using the classification procedure of the SPSS subprogram DISCRIMINANT. Using the 61-character set 99.12% correct classification of the OTUs was obtained, that is, only 3 of the 456 plants in this analysis had predicted group memberships which differed from the actual group memberships. One *S. vulgaris* var. *vulgaris* plant of line 13 was misclassified as *S. vulgaris* var. *vulgaris* line 15, and one plant of each of the *S. squalidus* lines 43 and 46 were misclassified as *S. squalidus* line 44. There were no misclassifications between varieties or species.

6. THE RESULTS OF THE CROSSING PROGRAM.

Three classes of interspecific hybridizations were attempted; diploid x diploid crosses between *S. squalidus* and *S. vernalis*, diploid x tetraploid crosses between *S. squalidus* and *S. vulgaris* var. *vulgaris*, *S. vulgaris* var. *hibernicus*, *S. vulgaris* var. *denticulatus*, *S. viscosus*, and *S. sylvaticus*, and tetraploid x tetraploid crosses between *S. vulgaris* var. *vulgaris*, *S. vulgaris* var. *hibernicus*, *S. vulgaris* var. *denticulatus*, *S. viscosus*, and *S. sylvaticus*.

Crosses involving the hexaploid *S. cambrensis* were not attempted, as the cytology and interfertility relationships of this species are the subject of a separate reseach program (Ingram & Noltie, in prep.). Diploid x tetraploid crosses involving *S. vernalis* were not attempted because of the extremely limited amount of *S. vernalis* material available. Only two *S. vernalis* plants were found during this study, one in Broughty Ferry near Dundee, the other in Dundee. Of these, only the Broughty Ferry plant set seed, and only three of the progeny of this plant survived to the flowering stage.

All crosses were accomplished using the emasculation technique described by Ordnuff (1964), where the anthers are removed by cutting off the upper part of the capitula before the styles elongate, irrespective of whether or not the female parent was self-incompatible. All crosses were attempted in both directions, although the number of different crosses varied depending on the availability of material, and the ease with which the crosses were accomplished. The crosses involving _S._ _vulgaris_ were replicated the most, using 173 emasculated capitula.

The diploid x diplod cross, _S._ _squalidus_ x _S._ _vernalis_, was successful in both directions, with seed sets of up to 38% being obtained. The F1 hybrids were self-sterile, but set seed when backcrossed to either parent.

Of the diploid x tetraploid crosses only those between _S._ _vulgaris_ var. _vulgaris_ x _S._ _squalidus_, _S._ _vulgaris_ var. _denticulatus_ x _S._ _squalidus_, and _S._ _squalidus_ x _S._ _viscosus_ were successful. The _S._ _vulgaris_ x _S._ _squalidus_ crosses were successful only when _S._ _vulgaris_ was the female parent. One triploid F1 hybrid of each of _S._ _vulgaris_ var. _vulgaris_ x _S._ _squalidus_, and _S._ _vulgaris_ var. _denticulatus_ x _S._ _squalidus_ were obtained. In addition a single tetraploid F1 hybrid of _S._ _vulgaris_ var. _vulgaris_ x _S._ _squalidus_ was obtained. This tetraploid F1 hybrid was partially self-fertile, giving a seed set of up to 15% when capitula were bagged, and fully interfertile with _S._ _vulgaris_ var. _vulgaris_, giving seed sets of up to 70% when backcrossed.

Tetraploid F1 _S._ _vulgaris_ var. _vulgaris_ x _S._ _squalidus_ hybrids were also synthesized by crossing colchicine induced autotetraploids of _S._ _squalidus_ with _S._ _vulgaris_ (Houston, 1982 unpub.). These F1 hybrids were also self-fertile.

The triploid _S._ _vulgaris_ var. _vulgaris_ x _S._ _squalidus_

F1 hybrid was completely sterile, all attempts to backcross it to either parent failed. The S. vulgaris var. denticulatus x S. squalidus F1 triploid was almost completely sterile. All attempts to backcross it to S. vulgaris failed, but a single seed was obtained when it was backcrossed to S. squalidus.

The other successful diploid x tetraploid cross, S. squalidus x S. viscosus was found to proceed in both directions, although previous attempts to synthesize this hybrid were successful only when S. squalidus was used as the female parent (Crisp, 1972; Crisp & Jones, 1978). The triploid F1 hybrids were completely sterile, and failed to set seed when backcrossed to either parent.

Of the tetraploid x tetraploid crosses, only those between S. viscosus and S. sylvaticus were successful, and proceeded in both directions. The S. vulgaris x S. viscosus and S. vulgaris x S. sylvaticus crosses were unsuccessful.

Intraspecific crosses between the three varieties of S. vulgaris, var. vulgaris, var. hibernicus, and var. denticulatus were made. All three varieties were found to be fully interfertile, and the intervarietal hybrids were also fully fertile. The interfertility relationships of the species and varieties of the British Senecio as determined by this crossing program are shown in Figure 6.1a. Figure 6.1b summarizes the reported results of other crossing programs involving these species (Crisp, 1972; Crisp & Jones; 1978; Ingram, 1977, 1978; Ingram, Weir & Abbott, 1980; Kadereit, 1984; Ingram & Nolties, unpub.).

The results of this crossing program suggest that the sterility of triploid hybrids is, at least in part, due to genomic imbalance, as the tetraploid hybrids are all fertile.

However, the results of this crossing program also illustrate the difficulties associated with the interpretation of such data. Kadereit (1984) argues that because the interfertility of artificially tetraploidized *S. vernalis* and *S. vulgaris* var. *vulgaris* was as high as 90.0%, it can be suggested that *S. vulgaris* is an autotetraploid derivative of *S. vernalis*. However, in this crossing program, similar levels of interfertility were found between artificiallly autotetraploidized *S. squalidus* and *S. vulgaris*. That is, *S. vernalis* and *S. squalidus* are interfertile, and synthetic autotetraploids of both *S. vernalis* and *S. squalidus* are interfertile with *S. vulgaris*, and therefore such data is inconculusive as evidence of evolutionary relationships.

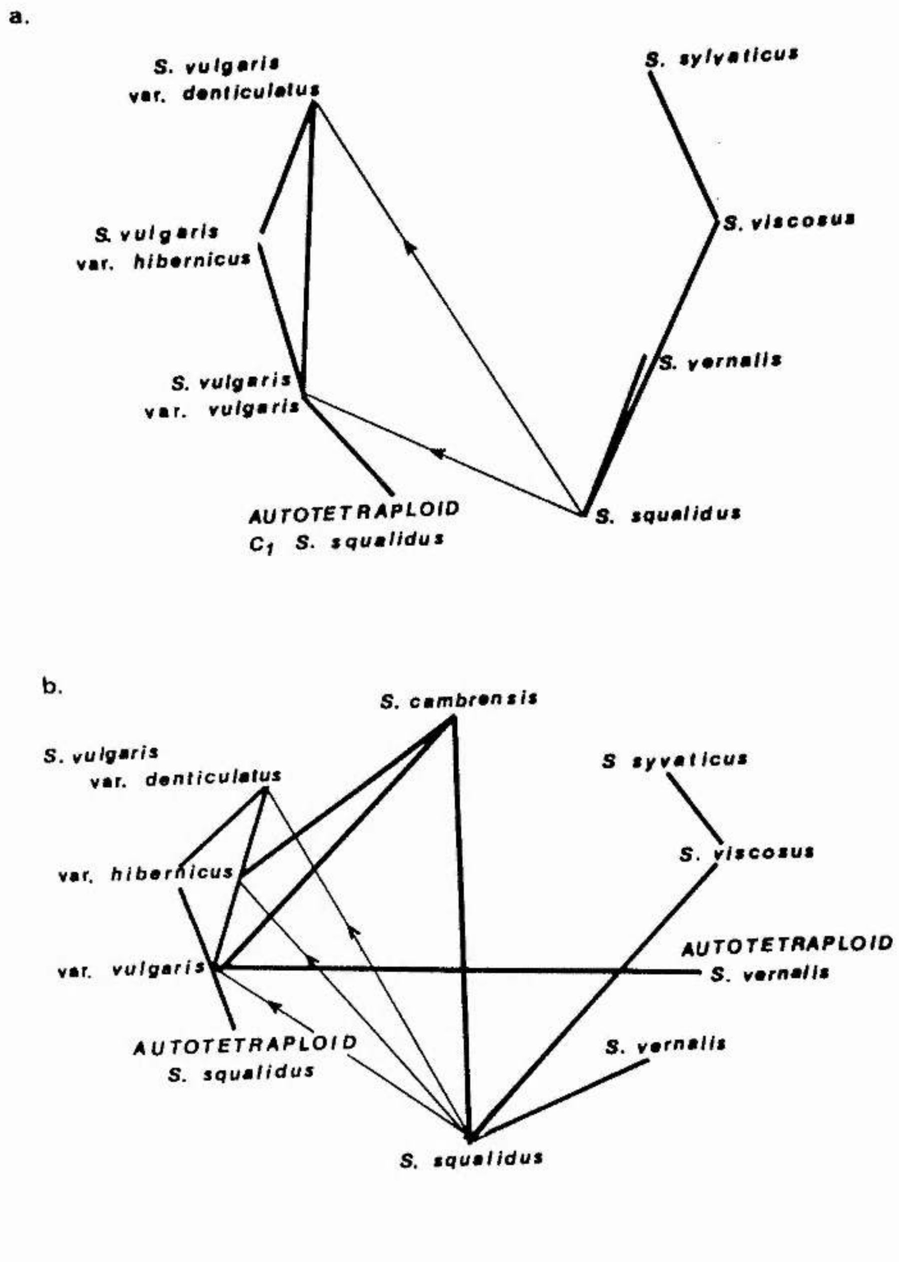


FIGURE 6.1 Interfertility relationships in British Senecio species (a) the relative interfertilities as determined in the current crossing program, and (b) the overall interfertilites as recorded to date (Crisp, 1972; Crisp & Jones, 1978; Alexander, 1975; Ingram, 1977, 1978; Kadereit, 1984). The thick lines indicate crosses which are frequently successful, and the thin lines indicate crosses which are very rarely successful.

7. NUMERICAL ANALYSIS OF INTERSPECIFIC HYBRIDS.

7.1 Materials and methods

The materials used were the 23 purebred species lines, the 11 synthesized hybrid lines, one autotetraploid S. squalidus line, and 4 lines of F_2 interspecific hybrids obtained from spontaneous seed set of wild population F_1 S. vulgaris x S. squalidus and S. x subnebrodensis. The line numbers assigned to the 39 lines are given in Table 7.1.1. Full details of the generation numbers and the orginal populations of the lines are given in Appendix 1. All plants were grown under standardized conditions and measured as discussed in section 5.2. The 61-character set given in Table 5.4.4 was used.

Two ordination and two clustering methods, discriminant function analysis and principal component analysis, and two clustering methods, the unweighted pair-groups method (UPGMA) and Ward´s error sum of squares (ESS) method, were used to analyse the data from the 571 plants.

Different clustering methods are predisposed to find different types of structure within the data set (Gordon, 1980). UPGMA is a space conserving method, whereas ESS is a space dilating method (Sokal & Sneath, 1973). However, if two different methods are used, then if the results agree with each other, it may be taken that the results have real biological meaning and are not artifacts of the clustering method.

Line No.	Species
1. Purebred species lines.	
11-17	*S. vulgaris* var. *vulgaris*
21-23	*S. vulgaris* var. *hibernicus*
31-32	*S. vulgaris* var. *denticulatus*
41-46	*S. squalidus*
51,52	*S. cambrensis*
61	*S. viscosus*
71	*S. sylvaticus*
81	*S. vernalis*
2. *S. vulgaris x squalidus* hybrids.	
111	*S. vulgaris* var. *vulgaris x S. squalidus* (2n=30)
131	*S. vulgaris* var. *denticulatus x S. squalidus* (2n=30)
141	F_1 hybrid (131) *x S. squalidus*
151	*S. vulgaris* var. *vulgaris x S. squalidus* (2n=40)
161	F_1 hybrid (151) selfed (2n=40)
171,172	F_1 hybrid (151) *x S. vulgaris* var. *vulgaris*
181	*S. vulgaris* var. *vulgaris x* C_2 *S. squalidus* (2n=40)
3. *S. x subnebrodensis* hybrids	
211	*S. squalidus x S. viscosus* (2n=30)
212	*S. viscosus x S. squalidus* (2n=30)
4. *S. vernalis x squalidus*	
331	*S. vernalis x squalidus* (2n=20)
5. Colchicine induced tetraploid lines.	
441	C_1 *S. squalidus* (2n=40)
6. F_2 hybrids from F_1 wild population hybrids.	
121	*S. vulgaris x squalidus* 2n=27
122	*S. vulgaris x squalidus* 2n=20,21
221	*S. x subnebrodensis* 2n=28
222	*S. x subnebrodensis* 2n=20

TABLE 7.1.1 The line numbers of the 39 species and hybrid lines grown under standard conditions.

The dicriminant function analysis was computed using the SPSS statistical package (version 9) subprogram DISCRIMINANT. The METHOD = RAO stepwise procedure was used. The predefined groups were the pure species and the synthesized hybrid lines. The wild population F_2 hybrids were classed as ungrouped. The principal component analysis and the cluster analyses were computed using CLUSTAN (Wishart, 1978). These three analyses were all computed from the squared euclidean distance matrix of standardized data. The 63 continuous variables were standardized using the means and standard deviations.

7.2 Discriminant function analysis.

The eigenvalues, percentages of variance, cumulative percentages of variance and the canonical correlations of the first ten of the 34 computed discriminant functions are given in Table 7.2.1. The standardized discriminant function coefficients of the characters included by the stepwise methods are shown in Table 7.2.3. Table 7.2.2 shows the discriminant function scores of the group centroids on the first five discriminant functions. Figure 7.2.1 shows the group centroids of the species and hybrid lines plotted against the first two discriminant functions. Figure 7.2.2 shows the 571 OTUs plotted against the first two discriminant functions.

From Figure 7.2.1 it can be seen that all the F_1

TABLE 7.2.1 Eigenvalues, percentages of variance, cumulative percentages of variance, and canonical correlations of the first ten discriminant functions.

function	eigenvalue	% of variance	Cumulative %	canonical correlation
1	92.93409	35.06	35.06	0.9946629
2	67.47825	25.45	60.51	0.9926716
3	39.80044	15.01	75.53	0.9876692
4	15.34395	5.79	81.31	0.9689248
5	11.61982	4.38	85.70	0.9595622
6	5.66140	2.14	87.83	0.9218901
7	4.72206	1.78	89.61	0.9084260
8	3.44290	1.30	90.91	0.8802965
9	3.32067	1.25	92.17	0.8766725
10	2.89617	1.09	93.26	0.8621702

TABLE 7.2.3 Canonical discriminant functions evaluated at group means (group centroids) .

GROUP	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
11	-11.00828	-1.06270	2.77322	-3.41754	-1.83662
12	-10.79876	-2.07065	3.82890	-3.55357	-2.08358
13	-12.07790	-2.52240	4.35434	-3.97528	-2.02538
14	-11.23554	-2.43726	4.70277	-3.29584	-1.38783
15	-11.15909	-1.77007	4.40115	-2.44551	-1.56189
16	-11.65937	-0.11199	0.24151	-2.87719	-3.39180
17	-8.41109	0.22729	2.49832	-4.49271	-3.57175
21	-9.32539	-1.18950	4.04463	-1.38783	-0.47130
22	-6.88245	1.88466	-0.17821	0.39192	-2.18384
23	-7.99936	-0.71080	2.73776	-1.54227	1.90289
31	-6.51055	7.41064	-4.17822	5.46387	-3.44026
32	-7.20275	9.12970	-8.68840	7.91788	-4.85608
41	10.24817	-5.98013	-3.92913	-1.37312	1.13838
42	8.77703	-0.85195	-2.23779	-3.03434	2.40106
43	10.13741	-4.08225	-3.10262	-4.46485	-2.07231
44	9.65447	-4.59887	-1.49781	-1.52072	-0.57459
45	10.55685	-2.36440	-1.67178	-2.90542	-1.12219
46	12.30224	-6.66701	-5.08976	-1.17191	-3.39606
51	-0.46570	-5.84140	1.73342	4.69239	6.57839
52	-0.76262	-3.47492	3.08346	5.52417	5.18704
61	15.77449	27.73384	13.62736	0.34286	-0.05582
71	-9.69139	19.78161	-24.82350	-9.01414	10.02311
81	1.99023	6.38972	-17.24208	-0.30219	-2.68294
111	-2.77772	-4.72152	1.84662	-1.50635	0.75073
121	6.72652	-4.09466	-1.88337	-3.19526	-2.64903
122	2.58687	0.06659	-1.24902	2.20427	-1.45134
131	-2.13887	1.80266	-3.28932	6.37136	-2.93654
141	-0.43033	-4.62820	-0.00851	5.85808	2.25037
151	3.02593	-4.09157	-0.54619	-0.30174	2.13527
161	2.97055	-4.43736	1.33273	2.77017	2.48587
171	-3.28482	-1.54091	2.19184	1.90358	3.39656
181	2.30380	-5.75537	1.12270	3.57325	0.75958
211	14.00766	20.20710	9.61303	-1.05947	-0.09226
212	14.44965	19.40879	11.23694	-1.97031	-0.02396
221	2.80845	-5.19954	1.13081	2.57556	0.62942
222	11.95818	-9.48453	-2.70001	1.11249	2.59750
311	7.44707	-1.19283	-3.79529	0.10547	-4.09631
411	15.48424	-11.80551	-2.99369	1.99368	-2.05608

TABLE 7.2.1 Standardized canonical discriminant function coefficients.

	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
C01	0.14954	0.01156	-0.03030	0.65853	-0.35733
C02	-0.05822	0.17719	-0.19322	-0.14624	0.03518
C03	0.20139	0.08348	0.00460	-0.19681	0.07653
C04	-0.18784	0.37402	-0.34278	-0.08578	0.15937
C05	0.05804	0.09851	-0.24582	0.07646	0.27769
C06	0.11917	0.07794	-0.35475	0.18538	-0.59742
C07	-0.31815	0.10475	0.23311	-0.06367	0.38481
C08	-0.20873	-0.29899	0.09308	0.43236	-0.02180
C09	-0.42113	0.34423	-0.18406	-0.15233	-0.17100
C101	0.30386	-0.20631	0.34296	0.03471	0.70359
C121	0.14009	-0.07786	0.15496	-0.19235	-0.00317
C14	0.02595	0.03535	0.05124	-0.05601	0.17063
C15	-0.28641	0.10918	0.03365	0.04761	-0.09786
C16	-0.03833	0.06994	0.10927	-0.31321	-0.02787
C17	0.27681	-0.09281	-0.07420	-0.27439	-0.20904
C18	0.08238	-0.07401	0.21668	0.02705	0.16006
C19	0.11826	-0.10861	-0.18789	0.39051	0.05932
C20	0.12620	-0.21771	-0.04776	-0.12795	0.06992
C21	-0.27897	0.05068	0.10874	-0.22954	0.03120
C23	0.06920	-0.10793	-0.01395	0.43001	0.12506
C24	0.01701	-0.01347	0.01266	0.18251	-0.03803
C25	0.06316	-0.09232	0.02431	0.08910	0.12633
C26	-0.07190	-0.03374	0.08471	0.25738	-0.12365
C27	-0.10015	-0.02995	0.04849	-0.10292	-0.02951
C28	-0.02281	0.07422	0.00869	-0.14066	-0.24474
C29	0.11030	-0.03395	-0.15034	-0.21014	-0.09284
C30	0.03813	0.00256	-0.04581	-0.03463	-0.06179
C31	0.04597	-0.07538	0.17593	0.02910	0.01884
C32	0.06537	0.03680	0.10452	-0.08879	0.12894
C33	0.03105	-0.01161	0.08305	0.20861	-0.10205
C34	0.00679	0.02926	-0.06999	0.19764	-0.12582
C35	0.13102	-0.11379	0.08222	0.09907	0.10303
C36	0.07290	-0.23595	-0.07911	-0.31594	-0.31892
C37	0.21047	0.08981	0.15909	0.28789	-0.01173
C38	0.07925	-0.02838	0.06516	0.05420	0.08718
C39	-0.00875	-0.10271	0.07905	-0.06559	-0.02093
C40	-0.32913	-0.03288	-0.12359	-0.03425	0.27935
C41	0.05032	0.01344	0.12534	0.13950	-0.07489
C421	-0.04678	0.01237	-0.40421	-0.35920	0.35807
C431	0.20184	0.41567	0.08215	0.00129	0.17906
C44	-0.20384	-0.00051	0.18475	0.22424	-0.10787
C45	0.14385	0.05666	0.11950	-0.32514	0.04890
C461	-0.32530	0.25837	-0.74086	0.05639	0.12272
C471	0.41817	0.62528	0.55211	-0.02201	-0.24165
C48	0.20018	-0.08300	0.12504	0.12303	0.14093
C49	-0.01943	-0.00091	-0.03435	-0.07706	0.01652
C51	0.04205	-0.13703	0.07565	0.23024	0.08156
C52	-0.09662	0.00022	0.19718	-0.00012	0.07665
C53	0.18974	0.11162	-0.17342	-0.11567	-0.01748
C54	-0.28282	0.29138	-0.20591	0.42779	-0.07667
C55	0.01564	-0.17856	0.02355	0.20442	-0.04660
C56	0.42652	-0.30804	-0.08744	-0.31198	-0.18102
C57	0.55641	0.05853	-0.13189	0.19735	0.56218
C58	0.04634	0.14920	-0.06663	0.49615	0.34812
C59	-0.12008	-0.47114	0.20764	-0.09349	-0.11193
C60	-0.01040	0.00002	-0.15852	-0.07588	-0.03937
C61	0.18459	-0.15935	0.00567	-0.01182	-0.08343
C62	-0.03062	0.13293	0.12863	-0.12903	0.09782
C63	-0.09535	-0.07699	-0.15213	-0.30117	-0.65118
C64	-0.39797	-0.41242	0.33008	0.16106	-0.16061

hybrid groups (111, 131, 151, 181, S. vulgaris x S. squalidus; 211, 212, S. x subnebrodensis; and 331, S. vernalis x S. squalidus) are intermediate between the parental lines. There is very little lateral displacement of the hybrid group centroids from a straight line drawn between the parental group centroids. Only line 141, which is the backcross of the triploid 131 onto S. squalidus, (S. vulgaris var. denticultus x S. squalidus) x S. squalidus, shows a marked displacement.

From this figure it can also be seen that the different classes of hybrids vary in their relative distances from both parental lines. The diploid F_1 group 331, resulting from the diploid x diploid S. vernalis x S. squalidus cross, and the tetraploid F_1 group 181 produced by the tetraploid x tetraploid S. vulgaris var. vulgaris x C_1 autotetraploid S. squalidus cross, are almost exactly intermediate between the parental lines. The four triploid F_1 groups resulting from diploid x tetraploid crosses; 111, 131 (S. vulgaris x S. squalidus), 211, 212 (S. x subnebrodensis) are all nearer the tetraploid parent than the diploid parent. However, the tetraploid F_1 hybrid 151 (S. vulgaris var. vulgaris x S. squalidus non-reduced gamete), and the tetraploid B_1 hybrid 141 (most probably resulting from the fusion of an unreduced triploid gamete of 131 with an haploid S. squalidus gamete), which both have the genomic constitution of two S. squalidus genomes plus one S. vulgaris genome, show the same relative nearness to S. squalidus.

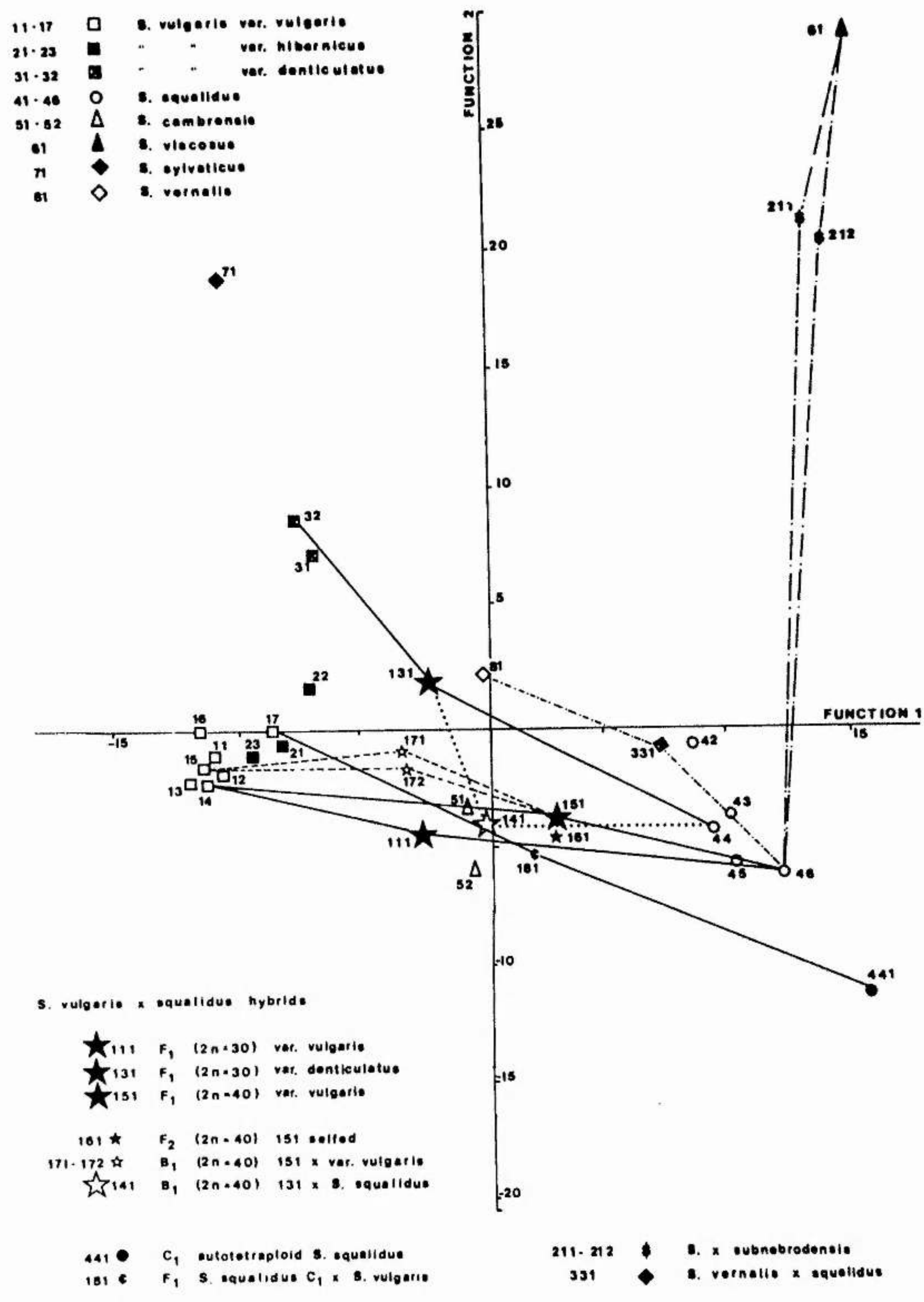


FIGURE 7.2.1 The group centroids of the species and hybrid lines plotted against the first two discriminant functions. The lines joining the centroids indicate successful crosses.

The proximity of the centroids of 151 and 181, the two tetraploid F_1 S. vulgaris var. vulgaris x S. squalidus hybrid groups, shows that although these hybrids were synthesized using different methods, the resultant morphology is similar. From Figure 7.2.2 it can be seen that there is considerable overlap of groups 151, 161, and 181 when they are plotted against the first two discriminant functions, although the full set of 34 functions gives complete discrimination of these three groups.

It can also be seen from Figure 7.2.1 that the direction in which the cross has been made does not affect the morphology. The two S. x subnebrodensis lines 211 (S. squalidus x S. viscosus) and 212 (S. viscosus x S. squalidus) have group centroids very close to each other. Discrimination between these groups using the classification functions is 94.4%.

Of the seven plants obtained from spontaneous seed set of F_1 hybrids found in natural populations; one (OTU No. 12101) was from a triploid S. vulgaris x S. squalidus hybrid found at Granton Docks, Edinburgh (Population O, in Table 9.1.1), and two were from a triploid S. vulgaris x S. squalidus hybrid found in Liverpool (OTU Nos. 12201 and 12202). These three F_2 hybrids had chromosome numbers of 2n = 20, 21, and 27 respectively. The other four F_2 hybrids were obtained from S. x subnebrodensis triploids; one plant (OTU No. 22101) with 2n = 28 was obtained from a hybrid found at Methil Docks, Fife (Population M), and the other three were from a plant found at Salamander St.,

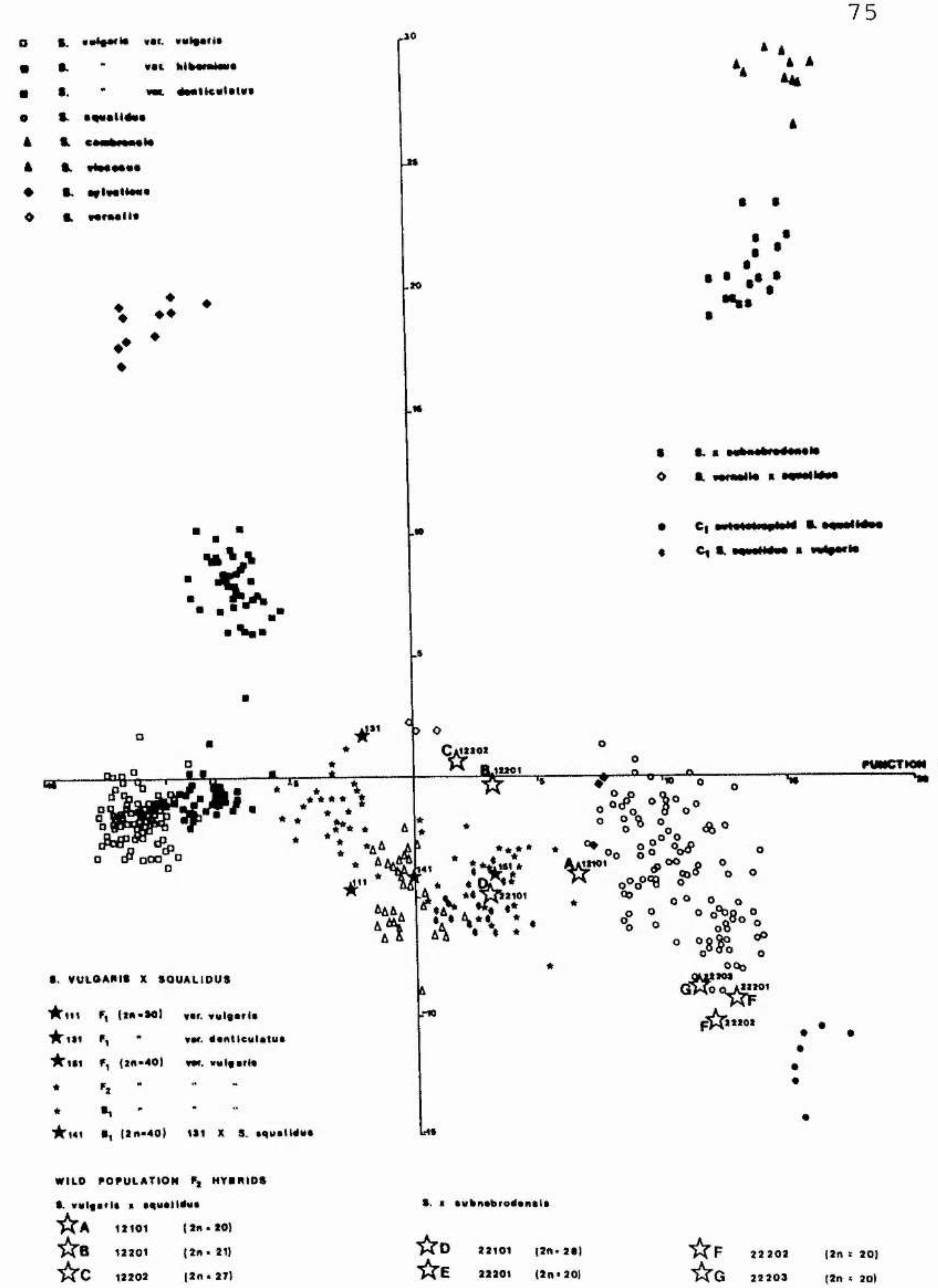


FIGURE 7.2.1 The 571 species and hybrid OTUs plotted against the first two discriminant functions.

Edinburgh (Population N). These three F_2 hybrids(OTU Nos 22201, 22202, ans 22203) all had chromosome numbers of 2n = 2C

It can be seen from Figure 7.2.2 that the three S. vulgaris x S. squalidus F_2 hybrids, labelled A, B, and C; where A is OTU No. 12101 (2n = 20), B is OTU No. 12201 (2n = 21), and C is OTU No. 12202 (2n = 27); are intermediate beween S. squalidus and S. vulgaris var. vulgaris. The degree of intermediacy is correlated with the chromosome number, particularly with respect to the first discriminant function.

Using the classification procdure of SPSS DISCRIMINANT it was found that 12101 (A) was grouped with S. squalidus line 44; 12201 (B) was grouped with line 161, the tetraploid S. vulgaris var. vulgaris x S. squalidus F_2 hybrids; and 12202 (C) was grouped with line 131, the S. vulgaris var. denticultus x S. squalidus F_1 hybrid.

The four F_2 S. x subnebrodensis hybrids, labelled D, E, F, and G, in Figure 7.2.2 are not intermediate between S. squalidus and S. viscosus. OTU No. 22101 (2n = 28) was grouped with line 181, the S. vulgaris var. vulgaris x C_1 S. squalidus tetraploid F_1, and the the three 2n =20 hybrids (E = 22201, F = 22202, and G = 22203) were all grouped with line 441, the autotetraploid S. squalidus line.

Therefore, four of these seven F_2 hybrids were morphologically and cytologically indistinguishable from S. squalidus.

7.3 Principal component analysis.

The eigenvalues, percentages of variance, and cumulative percentages of variance of the first 10 principal components are given in Table 7.3.1, and a plot of the 571 OTUs against the first two principal component axes is shown is Figure 7.3.1

The ordination shown in Figure 7.3.1 differs from that obtained by dicriminant function analysis (Figure 7.2.2) in a number of respects. The first principal component separates the S. squalidus OTUs into two groups, and this separation appears to be on the basis of growth conditions rather than on the basis of different lines. The OTUs which have negative component scores on the first axis were all from the first batch of plants grown, whereas the OTUs with positive component scores on the first axis were from the second and third batches. Also, the F_1 hybrid

Function	Eigenvalue	% of variance	Cumulative %
1	19.97	26.28	26.28
2	15.18	19.98	46.26
3	5.30	6.97	53.23
4	5.10	6.71	59.93
5	3.54	4.66	64.60
6	2.48	3.27	67.86
7	2.20	2.90	70.76
8	1.72	2.26	73.03
9	1.39	1.83	74.85
10	1.33	1.75	76.60

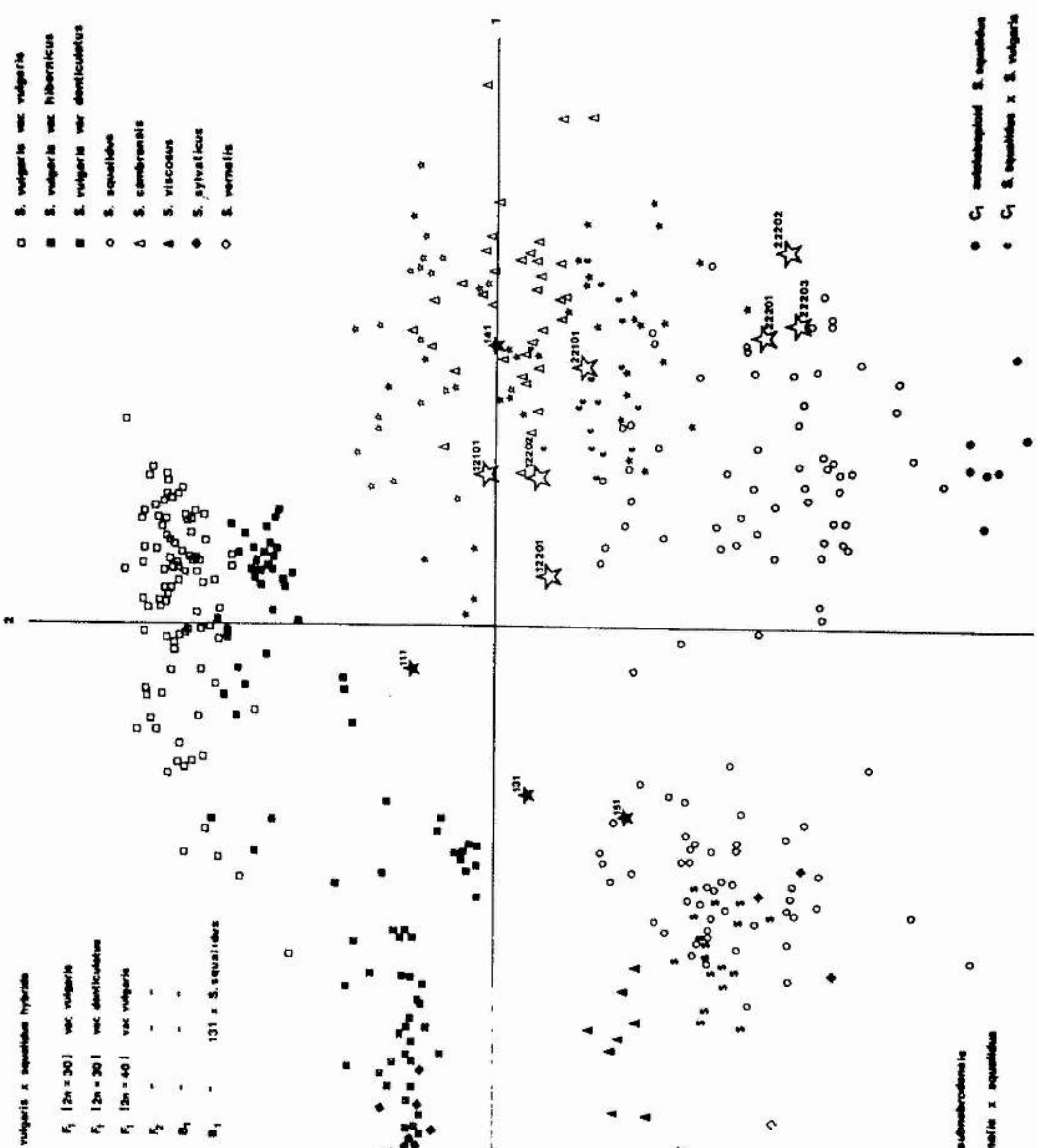
TABLE 7.3.1 Eigenvalues, percentages of variance, and cumulative percentages of avriance of the first ten principal components.

lines, which were sown in 1982, have negative comcnent scores, whereas the F_2 hybrid lines, which were grcwn in May and September 1983, all have positive component scores. The plants grown in 1982 were generally somewhat smaller and slower-growing than thcse grown in 1983. The other groups which have high negative first compcnent scores, S. sylvaticus, S. vernalis, and S. visosus, are also slcw-growing small-leaved species, and this would suggest that the first principal component is a growth or size compcnent.

The second component axis appears to be eqivalent to the first discriminant function in that it shows a clear separations cf the diploids with large capitula, i.e., S. squalidus and S. vernalis, from the tetraploids with small capitula , S. vulgaris and S. sylvaticus, with S. cambrensis and the various S. vulgaris x S. squalidus hybrid lines intermediate. The indumentum characters, C421, C431, C461, and C471, which contributed largely to the second and third functicns in the discriminant function analysis, appear to contribute little to the principal components.

The three wild populaticn S. vulgaris x S. squalidus F_2 hybrids, (12101, 12201, and 12202), and the S. x subnebrodensis F_2 which had 2n = 28 (OTU No. 22101) are relatively less close to S. squalidus in this ordinaticn, although the three diploid S. x subnebrodensis F_2 hybrids (CTU Nos. 22201, 22202, and 22203) still cluster with S. squalidus.

FIGURE 7.3.1 The 571 species, hybrid and wild population F_2 hybrid OTUs plotted against the first two principal component axes.



7.4 Cluster analysis.

Figure 7.4.1 shows the UPGMA phenogram of the 571 OTUs of the species, hybrid, and wild population F_2 lines. Figure 7.4.2 shows the ESS phenogram of the same material. The bars on these figure represent the various species or hybrid groups, and the shading of the bars represents the different lines or progeny of individual crosses within these groups.

The UPGMA phenogram clusters into 9 major groups at the 1.5 level of similarity, these groups comprising;

1. The 7 lines of S. vulgaris var. vulgaris (11 - 17); plus 2 of the 3 lines of S. vulgaris var. hibernicus (21,23).
2. 11 OTUs of the S. squalidus lines 42 and 43; the 2 S. cambrensis lines (51, 52); and the majority of the S. vulgaris var. vulgaris x S. squalidus hybrids, including all of lines 111, 141, 171, 172 and 181, and most of line 161. This cluster also includes the wild population S. vulgaris x S. squalidus F_2 OTU No. 12202 (2n=27), and the S. x subnebrodensis F_2 OTU No. 22101 (2n=28).
3. 45 OTUs of S. squalidus lines 43, 44, and 46; the autotetraploid S. squalidus line 441; one OTU of the tetraploid S. vulgaris var. vulgaris x S. squalidus line 161; the wild population S. vulgaris x S. squalidus F_2 OTU No. 12101 (2n=20); and the three S. x

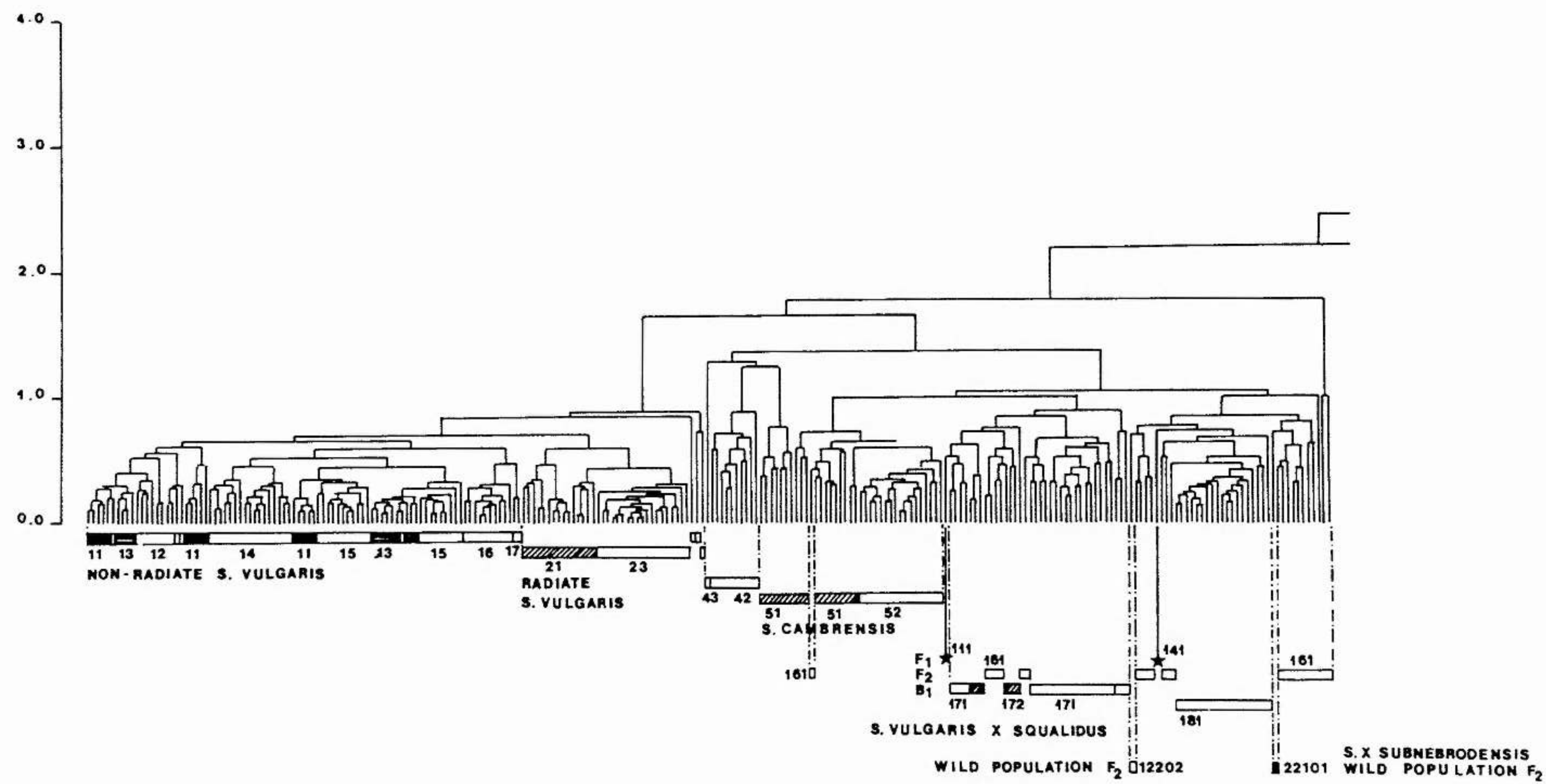


FIGURE 7.4.1 The unweighted pair group (UPGMA) phenogram of the 571 hybrid and specie- OTUs.

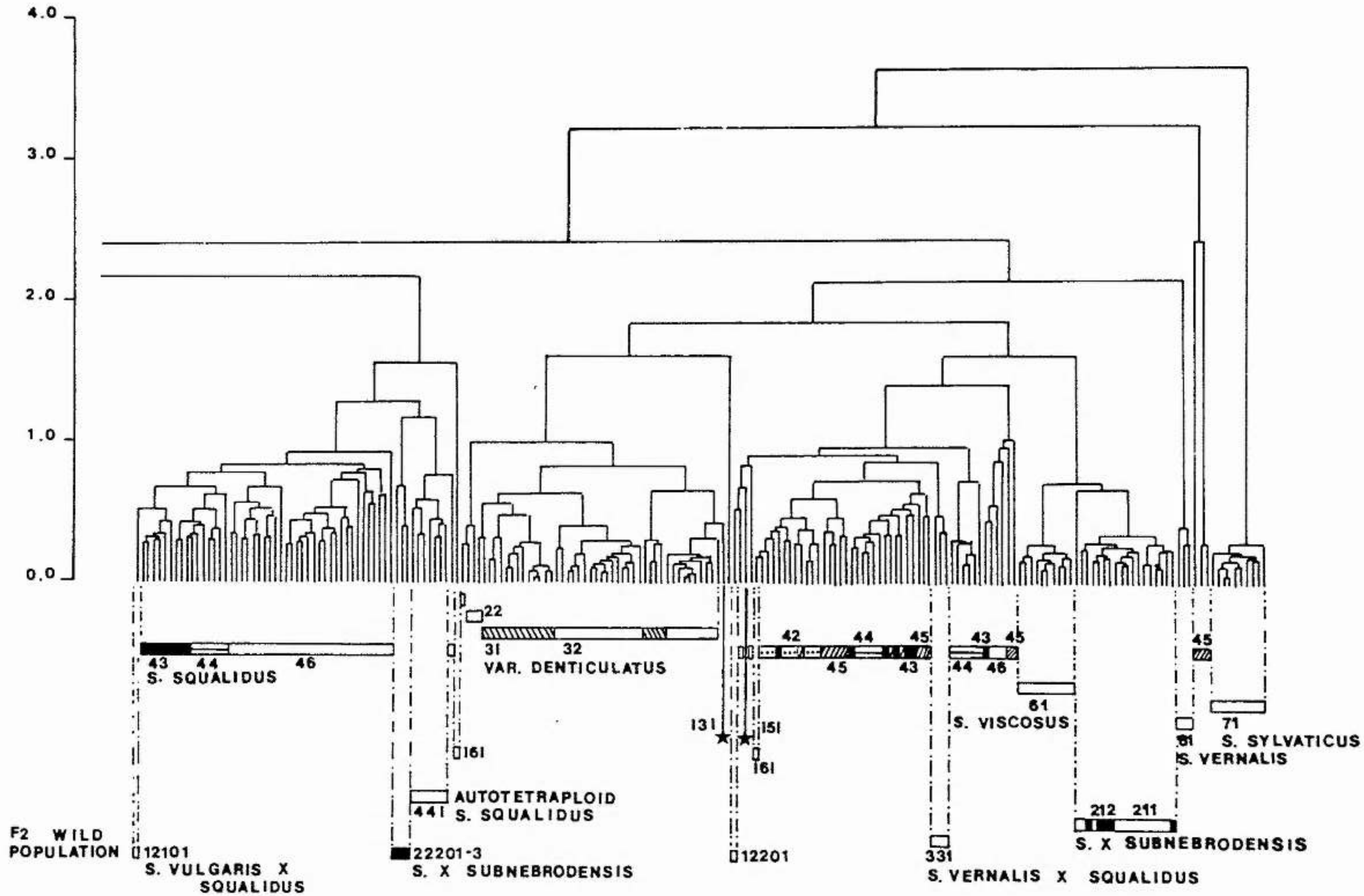


FIGURE 7.4.1 continued

subnebrodensis wild population F_2s OTU Nos. 22201, 22202, and 22203 (2n=20).

4. The S. vulgaris var. hibernicus line 22; the two S. vulgaris var. denticulatus lines 31 and 32; the S. vulgaris var. denticulatus x S. squalidus F_1 triploid 131; and the wild population S. vulgaris x S. squalidus F_2 OTU No. 12201 (2n=21).
5. 43 OTUs of the S. squalidus lines 41 to 46; the S. vernalis x S. squalidus F_1 hybrid line 331; the F_1 tetraploid S. vulgaris var. vulgaris x S. squalidus hybrid 151, and one CTU of line 161.
6. The S. viscosus line 61, plus the two S. x subnebrodensis F_1 hybrid lines 211 and 212.
7. The S. vernalis line 81.
8. Three OTUs of the S.squalidus line 45.
9. The S.sylvaticus line 71.

Cluster 1 fuses to cluster 2 at the 1.8 level, and then to cluster 3 at 2.2. Cluster 6 fuses to cluster 5 at 1.6, to cluster 4 at 1.76, and then to cluster 7 at 2.09. These two clusters then fuse at 2.43. The last 2 clusters, 8 and 9 then fuse at 3.22 and 3.64 respectively.

The ESS phenogram clusters into 9 major groups at the 10.0 similarity level, the groups being;

1. The 7 S. vulgaris var. vulgaris lines 11 to 17; plus 2 of the three S. vulgaris var. hibernicus lines 21 and 23.
2. 49 OTUs of S. squalidus lines 43,44, and 46; the autotetraploid S. squalidus line 441; and the 3 wild population S. x subnebrodensis F_2 hybrids OTU Nos.

22201, 22202, and 22203 (2n=20).

3. The S. vulgaris var. vulgaris x S. squalidus hybrid lines 141 and 181; 17 OTUs of the S. vulgaris var. vulgaris x S. squalidus F_2 hybrid line 161; and the S. x subnebrodensis wild population F_2 OTU No. 22101 (2n=28).
4. The S. vulgaris var. vulgaris x S. squalidus F_1 triploid hybrid 111, the backcross hybrid lines 171 and 172, 4 OTUs of the line 161, plus the 3 S. vulgaris x S. squalidus wild population F_2 hybrids (OTU Nos. 12101, 12201, and 12202).
5. The two S. cambrensis lines 51 and 52, plus 2 OTUs of the S. vulgaris var. vulgaris x S. squalidus line 161.
6. The S. vulgaris var. hibernicus line 22; the two S. vulgaris var. denticulatus lines 31 and 32; and the S. vernalis line 81.
7. The S. sylvaticus line 71.
8. 45 OTUs of the S. squalidus lines 41 to 46; the S. vernalis x S. squalidus F_1 hybrid line 331; The F_1 tetraploid S. vulgaris var. vulgaris hybrid 151; one OTU of the F_2 hybrid line 161.
9. The S. viscosus line (61) and the two S. x subnebrodensis lines (211, 212).

At the 100.0 level of similarity in the ESS phenogram there are three clusters, cluster 1, clusters 2 to 5, and clusters 6 to 9.

There are a number of differences between the UPGMA phenogram and the ESS phenogramm, in particular the

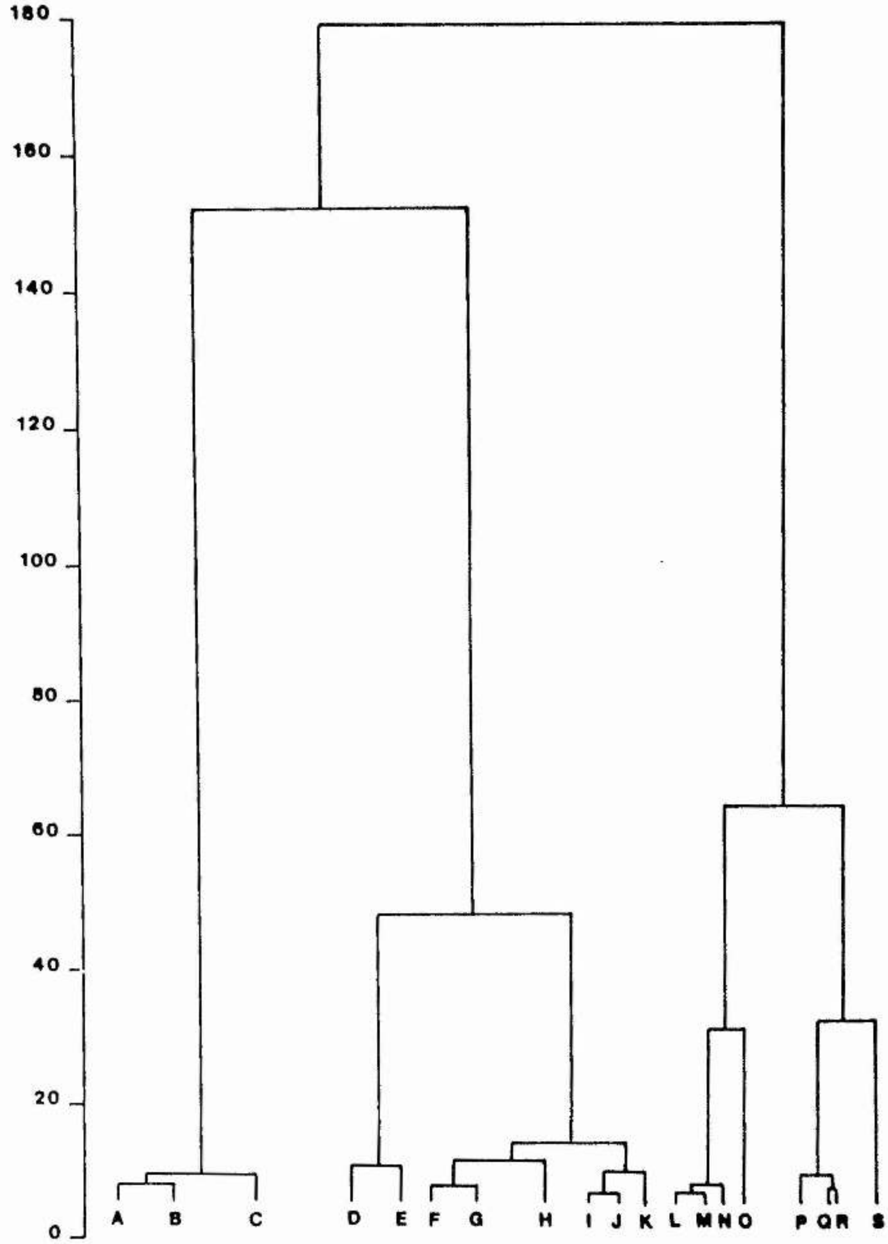


FIGURE 7.4.2 The error sum of squares (ESS) phenogram of the 571 species and hybrid OTUs.

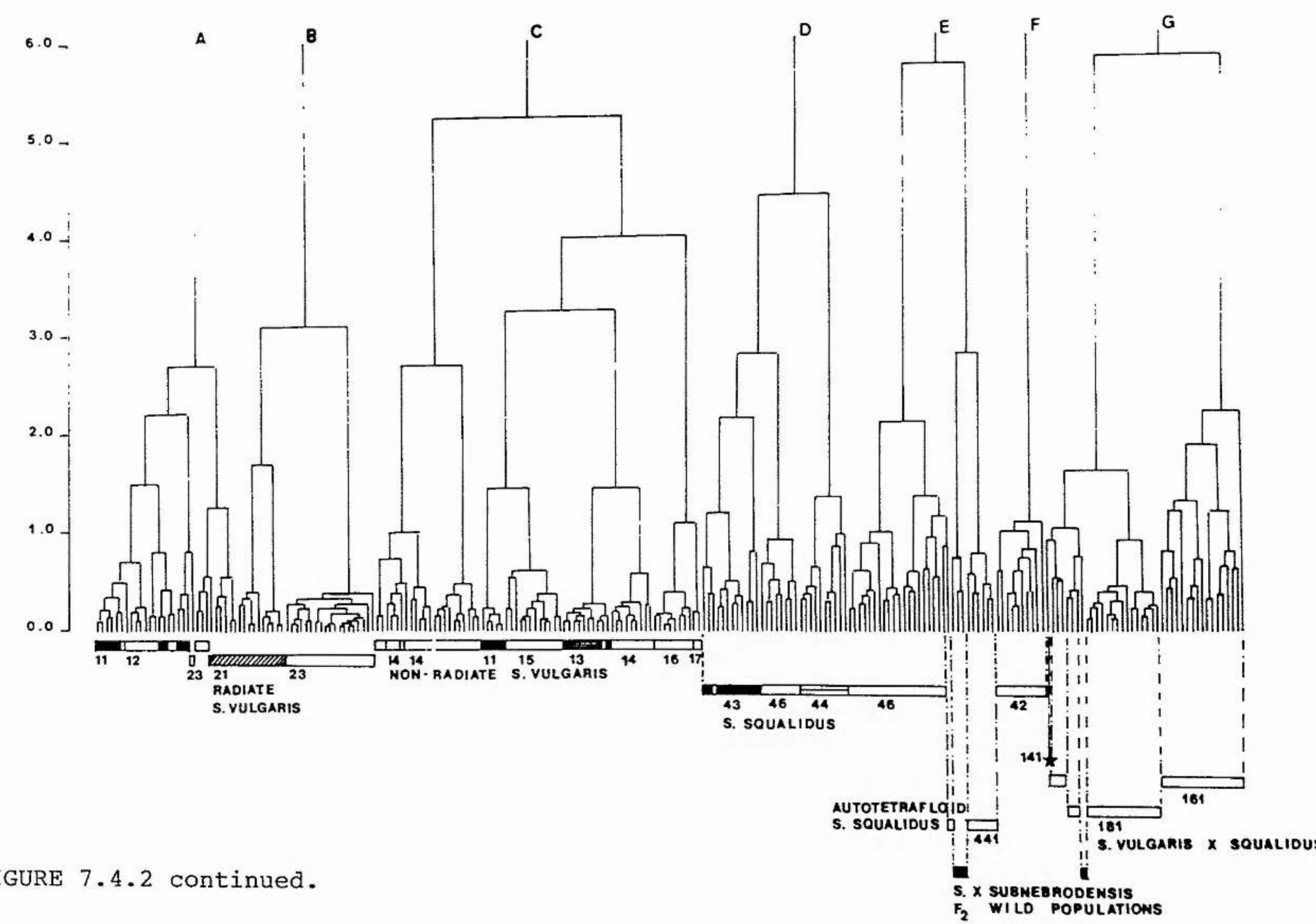
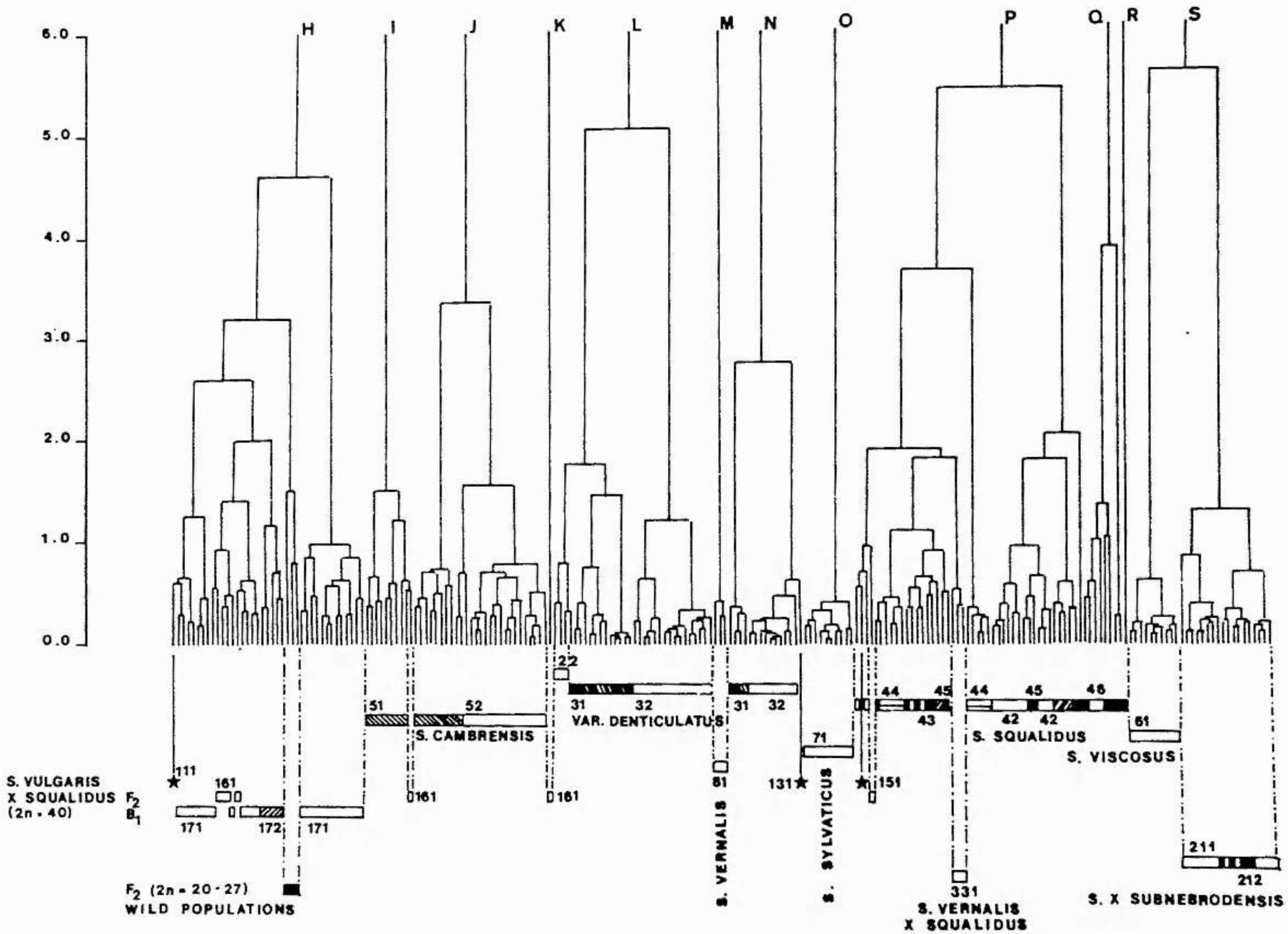


FIGURE 7.4.2 continued.

FIGURE 7.4.2 continued.



greater degree of chaining in the UPGMA phenogram, and the more intense clustering of the ESS phenogram. However, many of the clusters are the same, e.g., cluster 1 is the same in both phenograms, clusters 6 and 9 in the UPGMA phenogram are clusters 9 and 7 in the ESS phenogram. Although there are differnces in the order in which the clusters are fused, there are very few differences in the ordering of the OTUs within the clusters.

In both phenograms the S. squalidus OTUs occur in three separate clusters (a) the S. squalidus plants grown in 1982, including material from all 6 lines, (b) the OTUs of S. squalidus line 42 grown in 1983, and (c) the OTUs of S. squalidus lines 43, 44, and 46 grown in 1983. These three groups are located in clusters 5, 3, and 2 in the UPGMA phenogram and in clusters 8, 3, and 2 in the ESS phenogram. That is, in both phenograms the S. squalidus plants grown in 1982 cluster with S. vulgaris var. denticulatus, S. viscosus, S. x subnebrodensis, and S. vernalis x S. squalidus; whereas the plants grown in 1983 cluster with autotetraploid S. squalidus and the wild population S. x subnebrodensis F_2 hybrids which have 2n=20. This dichotomy was also seen in the component scores of the first axis of the principal component analysis (Figure 7.3.1)

Similarly in both phenograms the replicates of S. vulgaris var. denticulatus line 31 (from the Channel Is.) and line 32 (from Lancashire) grown in 1982 clustered with each other before clustering with the replicates grown in 1983.

The relative positions of the three S. vulgaris x S. squalidus wild population F_2 hybrids differ in the two phenograms. In the UPGMA phenogram OTU 12202 (2n=27) clusters with the the tetraploid S. vulgaris var. vulgaris x S. squalidus F_2 line 161, OTU 12201 (2n=21) clusters with the the tetraploid F_1 S. vulgaris var. vulgaris x S. squalidus hybrid 151, and OTU 12101 (2n=20) clusters with clusters with the 1983 S. squalidus. In the ESS phenogramm all three S. vulgaris x S. squalidus wild population F_2 hybrids cluster with the backcross (S. vulgaris var. vulgaris x S. squalidus) x S. vulgaris var. vulgaris lines 171 and 172.

The relative positions of the four S. x subnebrodensis wild population F_2 hybrids, however, are the same in both phenograms. OTU 22101 (2n=28) clusters with the S. vulgaris var. vulgaris x C_1 S. squalidus line 181, and the three 2n=20 F_2 hybrids (OTUs 22201, 22202, and 22203) cluster with the autotetraploid C_1 S. squalidus line 441.

On the basis of these two phenograms it is difficult to interpret the relationships of the species and varieties, as the phenograms differ completely at the higher levels of similarity. This difficulty is compounded by the fact that the S. squalidus OTUs formed three distinct and separated clusters. However, at the lower levels of similarity, there was considerable agreement within the clusters. In both phenograms, S. vulgaris var. vulgaris and S. vulgaris var. hibernicus clustered with each other initially, but S. vulgaris var. denticulatus only fused with these two varieties at a high level of similarity. The synthesized S. vulgaris var. vulgaris x S. squalidus hybrids clustered with S. cambrensis and S. squalidus (1983) rather than with radiate S. vulgaris, and the diploid (2n=20) wild population F_2 hybrids all clustered with S. squalidus.

7.6 Comparison of numerical methods.

The principal component analysis, the UPGMA clustering, and the ESS clustering all gave broadly similar results in that they defined 7 major groups;

1. S. vulgaris var. vulgaris plus S. vulgaris var. hibernicus.
2. S. squalidus (1983) plus autotetraploid S. squalidus.
3. S. cambrensis and S. vulgaris x S. squalidus hybrids.
4. S. squalidus (1982) plus S. vernalis x S. squalidus hybrids.
5. S. vulgaris var. denticulatus plus S. vernalis.
6. S. viscosus and S. subnebrodensis.
7. S. sylvaticus.

The primary division in these analyses is on the basis of growth habit and leaf size, i.e., groups 1 to 3 as compared with groups 4 to 7. The secondary division is on the basis of capitula dimensions. The ordination obtained by the discriminant function analysis gave the capitula dimension characters as having the greatest contribution to the first function, and the indumentum and growth characters contributing to the second function. In the principal component and the cluster analyses the S.

squalidus OTUs were clustered into 3 separate groups, whereas in the discriminant function analysis there was no separation of the 1982 and the 1983 plants. It is possible that, as discriminant function analysis differs from the other methods in that it takes the within-groups correlation into account, this division of S. squalidus is a result of redundancy of the leaf characters in the principal component and cluster analyses. The within-line character correlations of the midleaf characters of S. vulgaris, S. squalidus, and their hybrids are examined in the next section.

If the phenetic relationships given by the discriminant function, principal component, UPGMA and ESS cluster analyses are compared with the interfertility relationships as determined by the crossing program (Figure 6.1b) then it can be seen that there is very little congruence between them.

The phenetic distance between the autotetraploid S. squalidus line and the non-radiate S. vulgaris lines is much greater than the distance between the diploid S. squalidus and non-radiate S. vulgaris, but the interfertility between C_1 S. squalidus and non-radiate S. vulgaris is much higher. In the principal component and cluster analyses, S. vulgaris var. denticulatus clusters with S. vernalis with which it shows a moderate degree of interfertility, S. squalidus (1982) with which it shows a very low degreee of interfertility, and S. viscosus, with which it is not interfertile, before clustering with the other two varieties of S. vulgaris, var. vulgaris and var.

hibernicus, with which it is fully interfertile.

However, given the existence of reproductive isolating mechanisms within plant species, such as self-incompatiblity mechanisms, the incongruence between the interfertility relationships and the phenetic resemblences is not unexpected.

Hybrid fertility in inter-ploid hybrids between the diploid and tetraploid Senecio species appears to be largely dependent on the chromosome number, although to what extent the possible presence of self-incompatiblity alleles from the parent species may affect the fertility of the hybrids is unknown. There is a general correlation between ray floret length, ploidy level and breeding system in the sect. SENECIO (Alexander, 1975), the diploids with large capitula and large ray florets being self-incompatible, the tetraploids which have small capitula and ray florets are generally self-compatible. The diploids S. vernalis and S. squalidus are both self-incompatible (Gibbs, 1971; Crisp, 1972; Alexander, 1976). It is believed that the incompatibility system is a sporophytic one (Crisp, 1972), and therefore, unlike gametophytic self-incompatibility, will not break down when tetraploidization occurs.

8. VARIATION AND CORRELATION IN HYBRID LEAF CHARACTERS.

Anderson (1939, 1949, 1953) suggested that character coherence, i.e., character correlation , was a diagnostic feature of hybrids. More recently Grant (1981) has argued that this is an over-generalization, that although character coherence is a common feature of natural populations, it is not a universal one.

Grant (1978) compared the within-group correlation in both the total population and the hybrids for a number of species, and found that while some, e.g., Iris and Aquilegia, showed a higher degree of correlation in the hybrids as compared with the total population, in others, e.g., Opuntia, Oxytropis, and Gilia, the level of correlation was lower in the hybrids than in the total population.

Neff & Smith (1979) in a multivariate analysis of the sunfish genera Lepomis and Notropis, found that in both genera there was a greater scatter of the L. cyanellus x macrochirus and N. spilopterus x whipplei hybrids relative to their parental species when plotted against the first two principal component axes. This increased scatter was due to a decrease in the covariance between the characters in the hybrids, although there was some increase in the variability of the meristic characters in the Notropis hybrids.

Although some of the middle cauline leaves of the S. vulgaris var. vulgaris x S. squalidus F_2 hybrids were intermediate in shape between the the S. vulgaris var.

vulgaris and S. squalidus lines (lines 14 and 46 respectively), some of the hybrids had leaf shapes which were apparently unlike those of either parent. This may be seen by comparing Figures 8.1.1 and 8.1.2. Figure 8.1.1 shows the parental species leaf shapes, the triploid and tetraploid F_1 hybrid leaf shapes, which are intermediate in shape, and the tetraploid F_2 hybrids, which show an almost complete range of intermediacy between the parental species leaf shapes. Figure 8.1.2 shows the extreem leaf shapes of some of the F_2 hybrids.

The 23 character sub-set of the midleaf characters C09 to C34 for the OTUs of the S. vulgaris line 14, the S. squalidus line 46, the S. vulgaris x S. squalidus F_2 hybrid line 161, were analysed by principal component and UPGMA cluster analysis. The aim was to see if these apparently extreem leaf shapes were reflected in an increased scatter of the OTUs in euclidean space.

The UPGMA phenogram of the squared euclidean distance matrix is shown in Figure 8.1.3. From this figure it can be seen that the majority of the F_2 hybrids cluster with S. squalidus. Only one hybrid cluster with S. vulgaris. However, two of the leaves (OTU Nos. 16121 and 16127) are last to fuse into the phenogram. That is the leaf shapes S. vulgaris and S. squalidus were phenetically closer to each other than to these hybrids.

The eigenvalues, percentages of variance, and cumulative percentages of variance of the first ten principal components are given in Table 8.1.1. Figure 8.1.4a shows the OTUs plotted against the first two

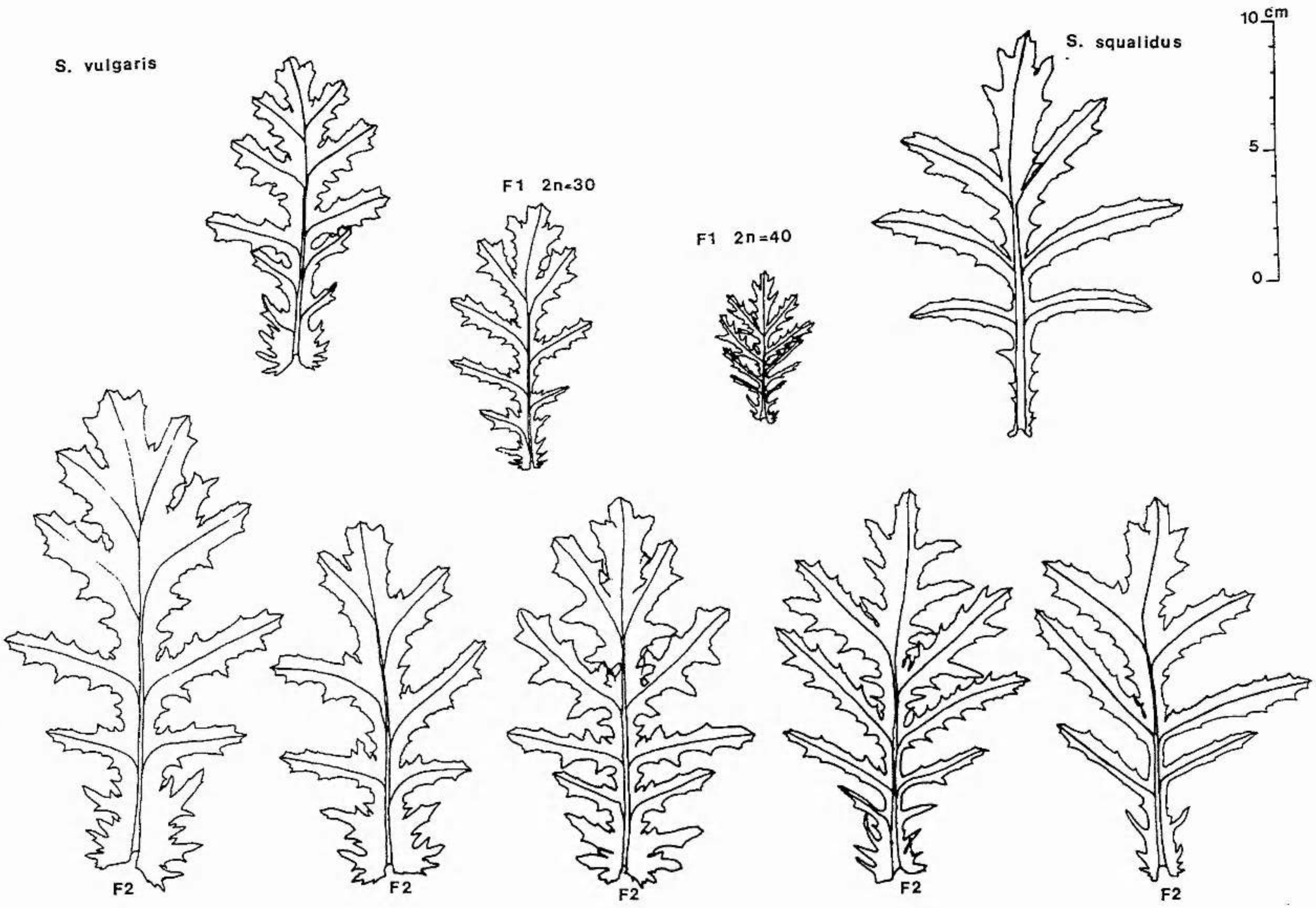


FIGURE 8.1 Illustrating the intermediacy of the leaf shapes in the F_1 and F_2 hybrids of S. vulgaris var. vulgaris x S. squalidus.

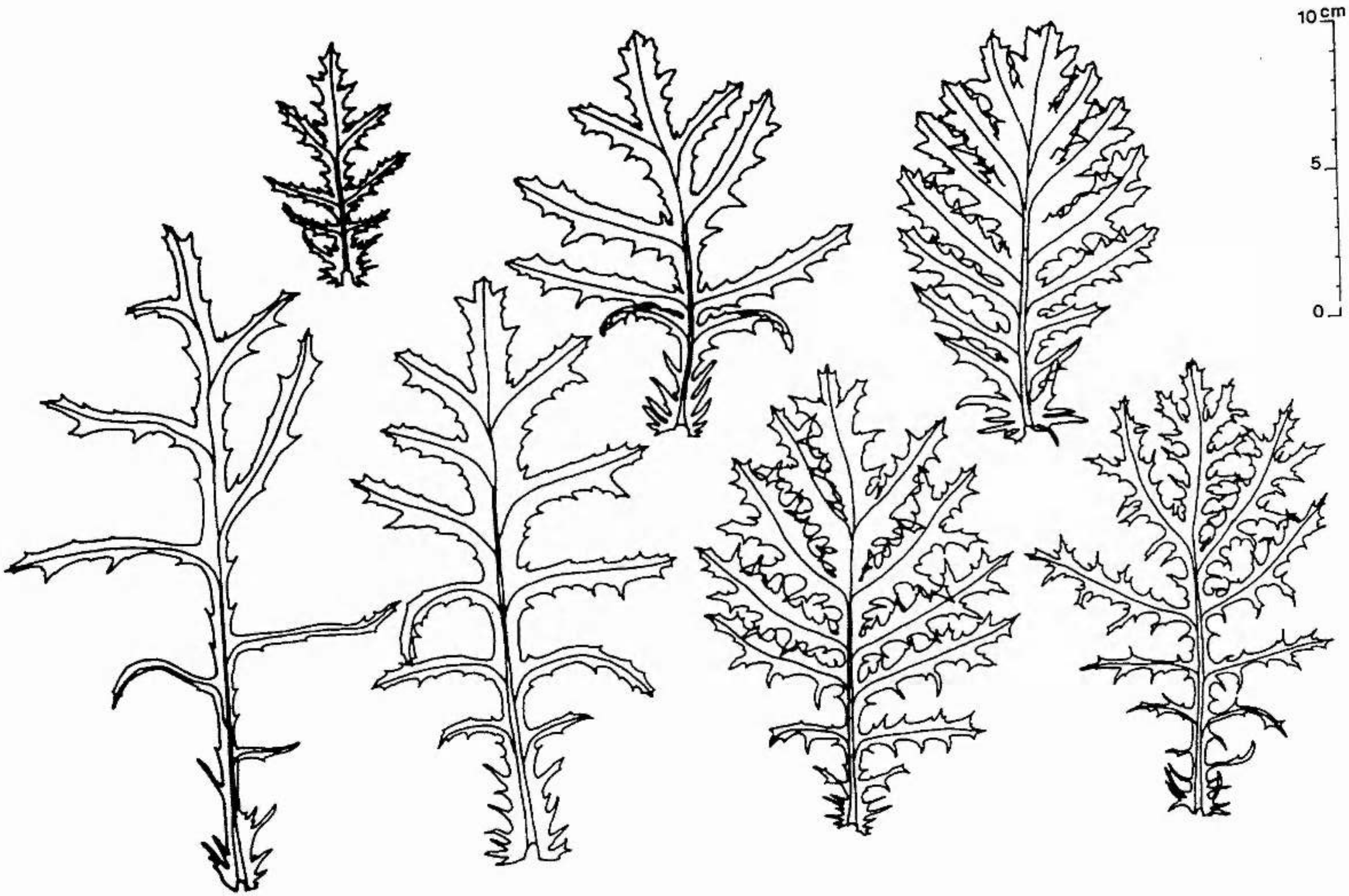


FIGURE 8.2 Illustrating the range of segregant leaf shapes in F_2 hybrids of S. vulgaris var. vulgaris.

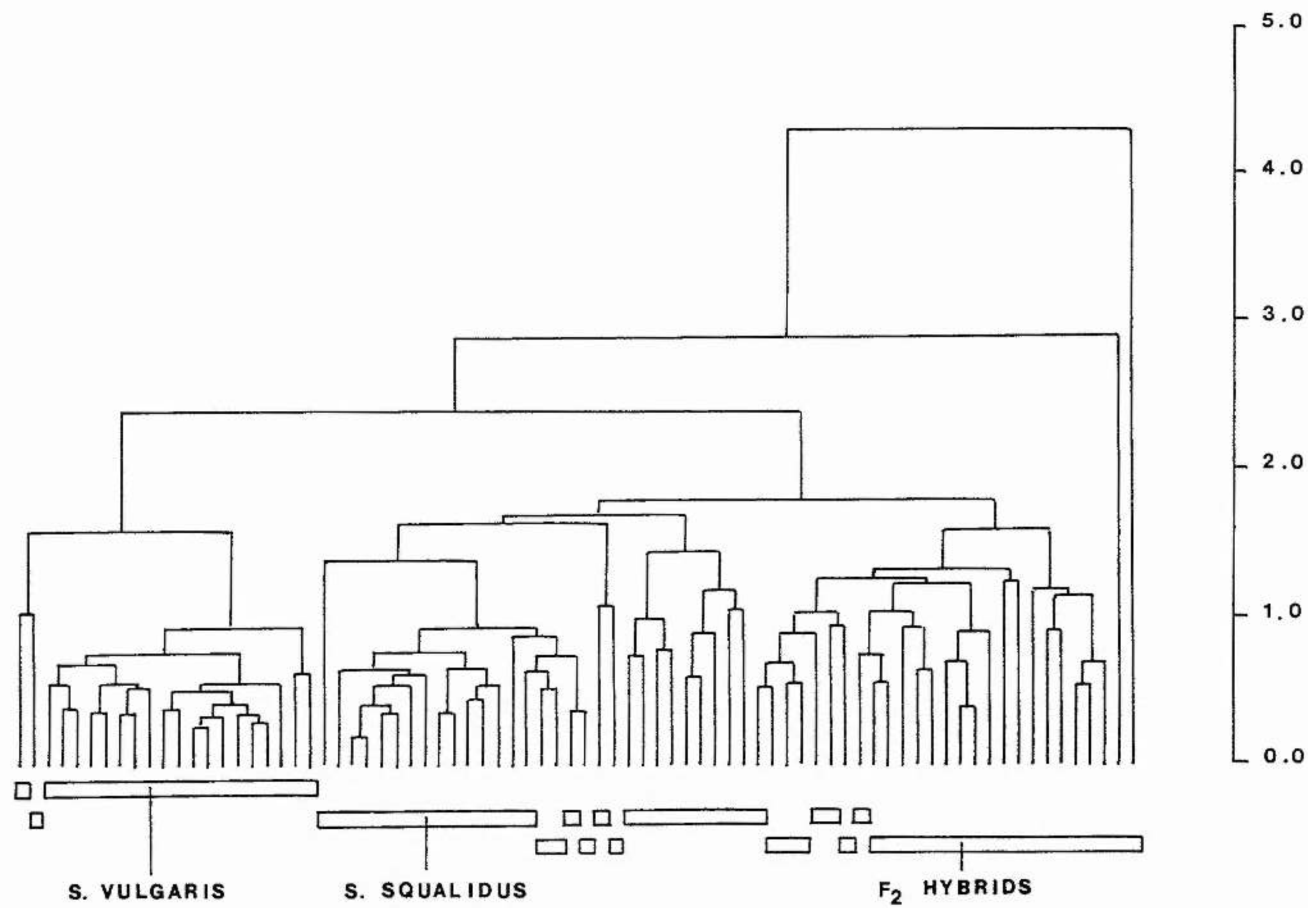


FIGURE 8.3 UPGMA phenogram of the S. vulgaris line 14, the S. squalidus line 46, and their F2 hybrid line 161, using the 23 midleaf characters.

TABLE 8.1 Eigenvalues, percentages of variance, and cumulative percentages of variance of the first 10 principal components.

Function	Eigenvalue	% of variance	Cumulative %
1	25.80	33.51	33.51
2	13.99	18.16	51.67
3	5.80	7.54	59.21
4	4.86	6.08	65.29
5	2.49	3.23	68.52
6	2.12	2.76	71.28
7	1.97	2.56	73.84
8	1.76	2.28	76.12
9	1.70	2.21	78.33
10	1.44	1.87	80.20

principal component axes, Figure 8.1.4b shows the OTUs plotted against the third and fourth axes. From these figures it can be seen that the hybrids show a rlatively greater scatter against the principal component axes than the parental lines, in particular the S. vulgaris line.

The means and variances of the 23 midleaf characters C09 to C34 for the parental species lines 14 and 46, the F2 hybrid line 161, and the backcross (S. vulgaris var. vulgaris x S. squalidus) x S. vulgaris var. vulgaris line 171 were compared.

The results of this comparison are given in Table 8.4, and from this table it can be seen that, in the F_2 hybrids, 13 of the characters had means which were greater than either parent, nine of the characters had means which were intermediate between the parents, and one character C29 (MLF Intercostal Length B) had a mean which was less than either parent. 13 of the characters had variances which were greater than those of either parent, and 10 had variances which were intermediate between their parents.

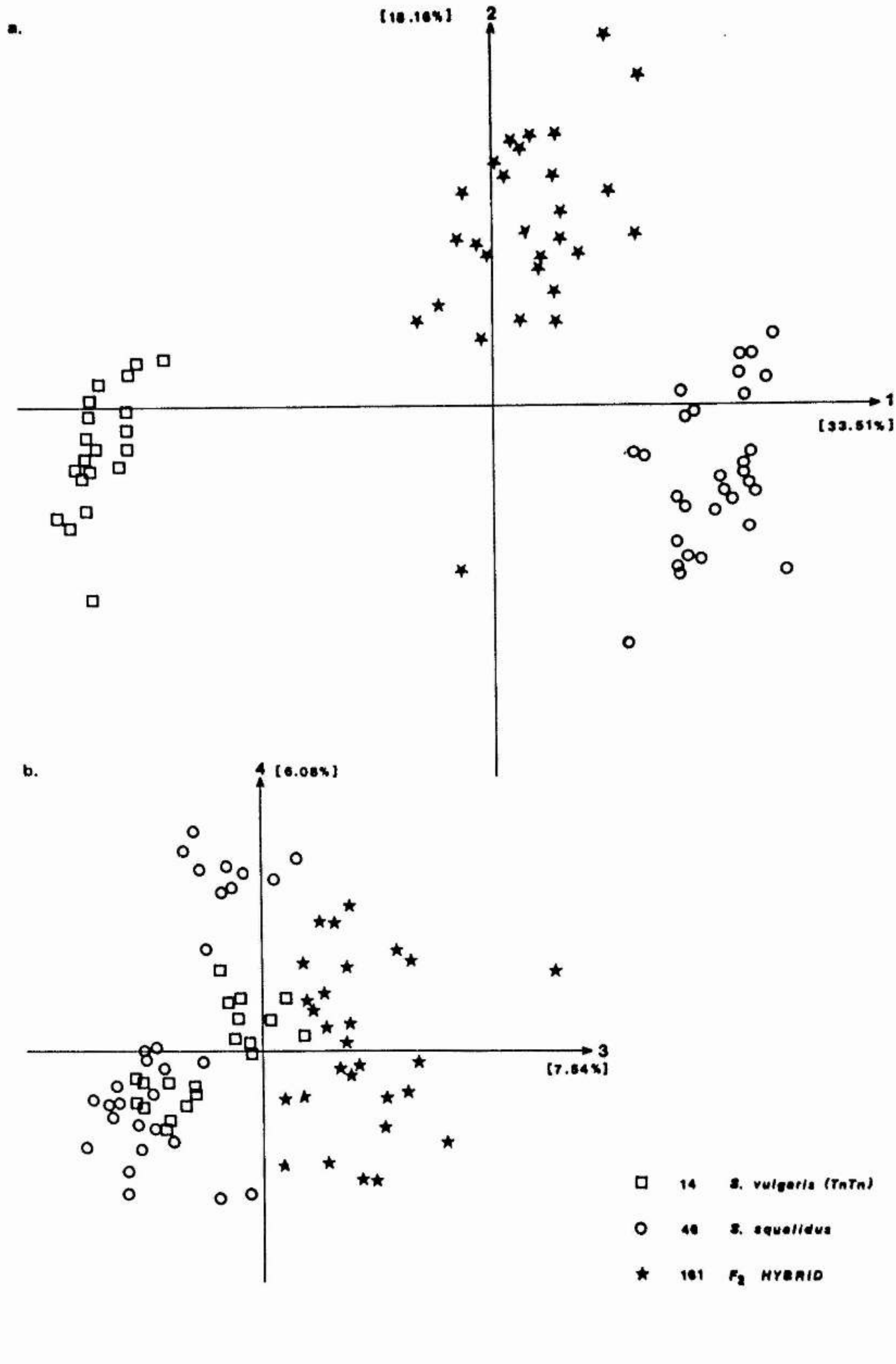


FIGURE 8.4 Plot of the OTUs of S. vulgaris var. vulgaris line 14, S. squalidus line 46, and their F_2 hybrid line 161 against (a) the first two principal component axes, and (b) the third and fourth principal component axes.

In the B_1 hybrids, 12 of the characters had means which were greater than the means of both the parental lines, nine had means which were intermediate, and twc of the characters, C29 (MLF Intercostal Length B) and C33 (MLF Basal Angle B) had means which were less than either parent. six of the character had variances which were greater than the variances of the parents, 15 had variances which were intermediate, and two had variances which were less than those of the parental lines.

However, the increased scatter of the F_2 hybrids is not entirely due to the inreased variability. If the the within-line character correlation coefficients are compared, then, as shown in Figure 8.5, there are differences in the distribution of the coefficients. The S. vulgaris var. vulgaris line had a mean correlation of +0.421, the S. squalidus line had a mean correlation of +0.356, whereas the F_2 hybrid line had a mean correlation of only +0.129.

That is, in addition to an increase in variability in the hybrids, there has been considerable breakdown in the character correlations. Therefore, if a decease in character coherence is associated with interspecific hybridization between S. vulgaris var. vulgaris and S. squalidus, then if S. vulgaris var. hibernicus is the product of introgression of S. vulgaris var. vulgaris into S. squalidus, then it may alsc show a reduced level of character correlation.

The character correlations of the 23 midleaf characters of S. vulgaris var. vulgaris line 11 and S.

vulgaris var. *hibernicus* line 21 were compared. These two lines originated from the same population, and were both selfed for two generations (see Appendix 1). The distribution of the correlation coefficients for these two lines are shown in Figure 8.6. The non-radiate line 11 had a mean correlation of +0.312, and the radiate line had a mean character correlation of +0.267. That is there was a slight reduction in character coherence in the radiate line.

	S. vulgaris line 14		S. squalidus line 46		F_2 hybrid line 161		B_1 hybrid line 171	
	mean	var.	mean	var.	mean	var.	mean	var.
C09	127.15	168.66	132.85	985.82	152.75	789.45	142.50	711.00
C101	63.15	100.97	82.61	585.33	99.75	238.19	96.80	238.22
C121	70.32	99.03	72.83	345.85	82.67	221.15	76.25	268.88
C14	23.00	17.15	8.02	24.33	20.56	26.77	28.15	65.50
C15	30.05	39.94	9.70	29.21	27.32	99.78	46.20	97.11
C16	11.15	0.87	7.29	1.12	9.50	2.55	8.70	1.48
C17	28.25	22.09	49.41	136.06	48.96	85.88	49.35	98.55
C18	15.55	7.20	18.50	34.13	24.42	62.10	25.65	41.71
C19	36.95	22.47	55.67	196.46	61.21	86.54	57.05	82.26
C20	35.15	27.50	50.61	138.60	57.10	72.84	54.55	59.31
C21	6.60	1.93	4.70	3.79	7.92	5.10	9.20	5.95
C22	18.90	20.30	31.06	88.48	33.14	89.83	25.65	148.66
C23	8.40	2.56	9.20	13.44	12.57	17.36	12.45	8.05
C24	14.00	22.94	26.29	93.48	32.64	88.60	25.70	56.47
C25	6.60	1.62	4.91	2.38	6.10	4.61	6.15	2.34
C26	14.45	12.78	7.26	3.35	9.07	8.21	12.80	11.32
C27	7.05	1.62	4.00	2.36	5.32	3.56	5.15	2.66
C28	19.00	19.26	26.23	178.12	23.21	38.87	23.55	38.26
C29	21.70	13.69	20.97	41.12	20.14	39.31	20.45	14.15
C30	84.40	166.67	61.61	195.45	67.75	322.49	78.70	190.43
C31	108.50	81.84	99.79	93.68	111.14	130.20	103.10	67.04
C33	113.80	942.37	180.55	1814.25	134.35	1363.57	87.30	426.11
C34	68.65	35.81	51.88	131.56	53.85	179.01	57.15	104.55

TABLE 8.2. Means and variances of the midleaf characters C09 to C34 for S. vulgaris var. vulgaris line 14, S. squalidus line 46, the S. vulgaris x S. squalidus F_2 hybrid line 161, and the S. vulgaris x S. squalidus backcrossed to S. vulgaris line 171.

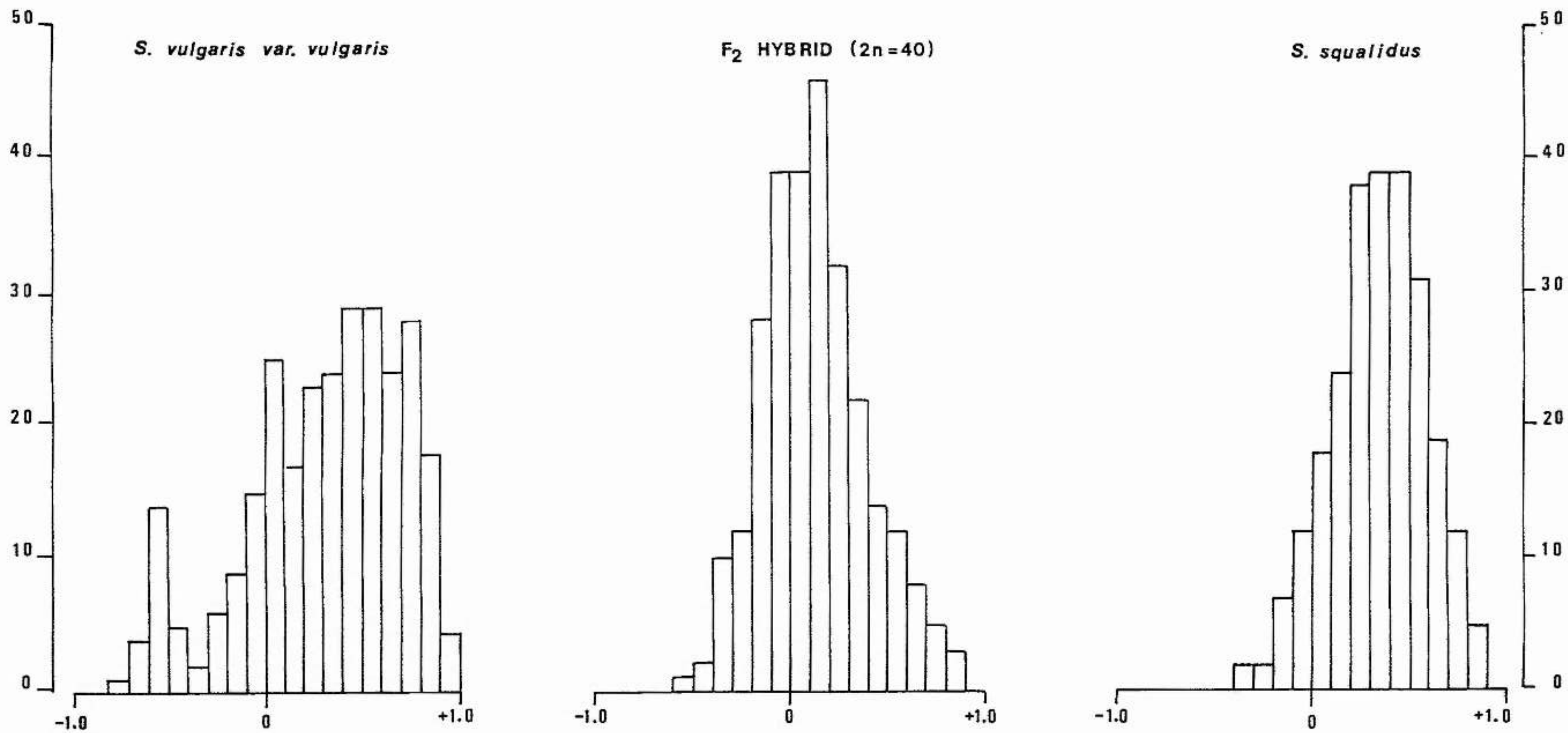
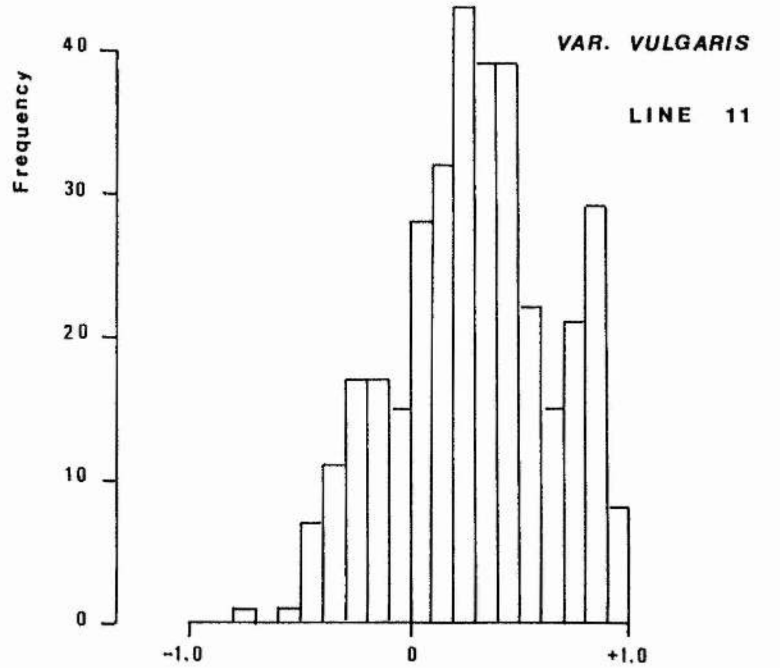


FIGURE 8.5 Histograms of the product-moment correlation coefficients of the 23 midleaf characters for the S. vulgaris var. vulgaris line 14, the S. squalidus line 46. and their F_2 hybrid line 161.



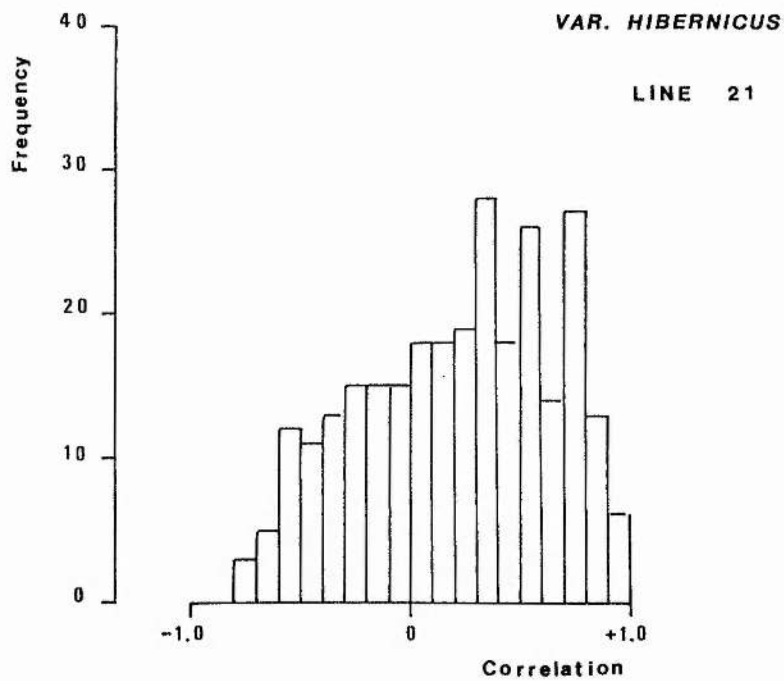


FIGURE 8.6 Histograms of the product-moment correlation coefficients of the 23 midleaf characters for the S. vulgaris var. vulgaris line 11, and the S. vulgaris var. hibernicus line 21.

9. GEOGRAPHIC VARIATION.

9.1 Materials and methods.

Samples were taken of each of the _Senecio_ species, varieties and hybrids found at 21 sites in central Scotland. The position of the area studied is shown in Figure 9.1.1a. The locations of the 21 sites, designated populations A to U, are shown in Figure 9.1.1b. The 21 sites formed two approximately east-west transects. The northern transect, from Dundee to Dumbarton (populations A to J) comprised 10 populations which were monomorphic for the non-radiate _S. vulgaris_ var. _vulgaris_, and from which _S. squalidus_ was absent. The southern transect, from Leven Fife to Glasgow (populations K to U) included both populations which were monomorphic for non-radiate _S. vulgaris_ (populations K and L), and populations which included both radiate and non-radiate _S. vulgaris_ (populations M to U). _S. squalidus_ was present at all 11 of these populations. The monomorphic _S. vulgaris_ populations are marked by open circles in Figure 9.1.1b, and the polymorphic populations by filled circles. The locations of the populations, and the number of plants of each species sampled at each site, are given in Table 9.1.1.

The 21 sites were sampled between May and October 1983. The order in which the populations were sampled was randomized, and where possible each population was sampled on two separate dates. The number of samples taken from

Population	Area	Location	O.S. Grid Ref.	No. of plants sampled of each species 1†	2.	3.	4.	5.	6.	7.
A	DUNDEE	Dens St.	343 733	10						
B	DUNDEE	Gurthrie St.	341 732	10						
C	DUNDEE	Brown St.	338 731	10						
D	CUPAR	Main St.	337 715	10						
E	PERTH	Flats RB.	313 723	20						
F	PERTH	DHSS car park	311 725	10						
G	STIRLING	Forth St.	270 695	2				5		
H	STIRLING	Broomemedow Rd.	267 693	10				3		4
I	DUMBARTON	Central Station	241 674	20						
J	DUMBARTON	Flats OP	239 674	20						
K	LEVEN	North St.	339 702	10			3	2	1	
L	LEVEN	Hawksmill Ind. Est.	338 701	6			10	10	5	
M	METHIL	Docks	336 699	6	10		5	10	10	
N	EDINBURGH	Salamander St.	330 674	20	20	2	17			
O	EDINBURGH	Granton Docks	325 676	16	16		10	9	4	
P	EDINBURGH	Blackchapel St.	328 673	10			+			
Q	BONESS	Kinneil Tip	298 682	10	10	1	6	6	1	1
R	GRANGEMOUTH	Devon St.	292 683	11	1		+	8		18
S	GLASGOW	Beith St.	256 666	20	+		+			
T	GLASGOW	Harmsworth St.	254 667	20	20		9	6	1	
U	GLASGOW	Princes Dock	257 665	20	20		3			

† 1. *S. vulgaris* var. *vulgaris* (TnTn)
2. *S. vulgaris* var. *hibernicus* (TrTr)
3. short rayed *S. vulgaris* (TrTn)
4. *S. squalidus*
5. *S. viscosus*
6. *S. x subnebrodensis*
7. *S. sylvaticus*

TABLE 9.1.1 Geographic locations of the 21 natural populations sampled, and the number of plants of each species sampled at each populaton.

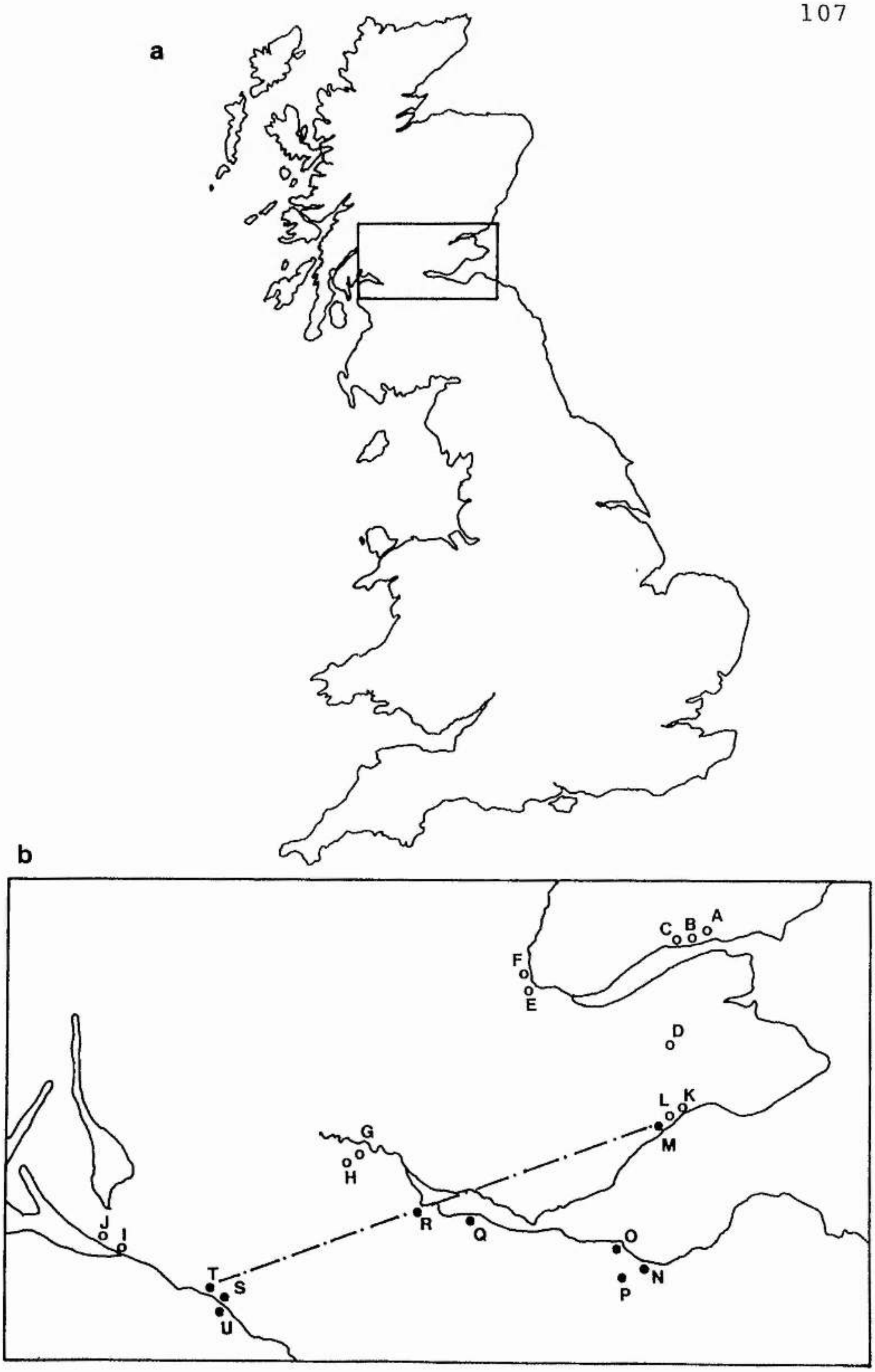


FIGURE 9.1.1 Showing (a) the location of the area cf central Scotland which was surveyed, and (b) the locations of the 21 populations sampled.

each population was determined by the number of available plants at the correct growth stage, but, where possible, between 10 and 20 plants of each type were sampled. The plants were sampled when the apical capitulum was at full anthesis. The method of measurement was as described in section 5.2.

A number of changes to the character set were necessary. C01 (Days to Flowering) could not be measured and therefore was excluded from the character set. Characters C30 (MLF Apical Angle A) and C41 (Proportion of Phyllaries with Black Tips) were excluded because of difficulties in accurate measurement. C59 was taken as the number of 'outer florets' rather than the number of ray florets, as discussed in section 5.1.

9.2 Interspecific variation.

A discriminant function analysis analysis of the 543 plants sampled using the 58-character set was computed using SPSS subprogram DISCRIMINANT. The groups were defined as the 7 species and hybrid groups found in the natural populations. The groups were, 1. non-radiate _S. vulgaris_, 2. radiate _S. vulgaris_, 3. short-rayed _S. vulgaris_, 4. _S. squalidus_, 5. _S. viscosus_, 6. _S. x subnebrodensis_, and 7. _S. sylvaticus_. The RAO stepwise method was used.

The eigenvalues, percentages of variance, cumulative percentages of variance, and the canonical correlations of

TABLE 9.2.1 EIGENVALUES, PERCENTAGES OF VARIANCE, cumulative percentages of variance and canonical correlations of the six discriminant functions.

function	eigenvalue	percent of variance	cumulative percent	canonical correlation
1	175.50053	54.61	54.61	0.9971631
2	83.60808	26.02	80.63	0.9940728
3	51.28615	15.96	96.59	0.9903911
4	8.56391	2.66	99.25	0.9462770
5	2.22450	0.69	99.94	0.8305868
6	0.17970	0.06	100.00	0.3902946

TABLE 9.2.2 Canonical discriminant functions evaluated at group means (group centroids).

GROUP	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
1	-9.15605	-3.19465	2.13034	1.56562	0.04714
2	-3.30150	1.58169	0.18199	-6.13275	-0.05893
3	-7.33908	-1.32234	2.40929	-1.73268	-0.97860
4	8.82257	23.51471	1.29594	1.79995	-0.59198
5	23.04844	-0.94911	-0.69434	0.41200	7.30513
6	30.97647	-11.15517	3.98544	0.36015	-1.56295
7	2.28039	-2.74193	-28.01653	1.11996	-0.53528

TABLE 9.2.3 Standardized canonical discriminant function coefficients.

	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
C02	-0.01469	-0.11943	-0.06424	-0.05265	0.09138
C03	0.01911	0.07792	-0.00865	0.15740	-0.09346
C04	-0.02649	0.07960	0.02013	0.31510	-0.20485
C06	0.09884	-0.17728	0.10153	-0.14049	-0.11945
C07	-0.11063	0.04502	0.03740	-0.01541	0.16884
C08	-0.13979	0.03565	0.24726	-0.00570	-0.12630
C09	0.01326	-0.14055	-0.35484	0.14463	0.53812
C101	0.11499	0.00178	0.06465	-0.09272	-0.33817
C121	-0.08003	-0.02578	0.31850	-0.13305	-0.25447
C14	-0.08148	-0.21364	-0.01144	-0.13042	0.25402
C17	0.31549	0.18372	0.15644	-0.10586	-0.03917
C18	-0.06861	0.10002	0.00886	0.13675	-0.08379
C16	0.02870	-0.13169	0.02242	-0.08153	0.00003
C20	-0.34025	0.08402	-0.41266	-0.00665	-0.06717
C21	0.01899	-0.08593	0.01790	-0.16601	-0.06680
C22	0.32749	0.05729	-0.10222	0.23224	0.12189
C24	-0.06201	0.02274	0.19389	-0.02650	0.21348
C25	0.14655	-0.02753	-0.00642	0.17705	0.07692
C26	0.00365	-0.01291	-0.02745	-0.08518	0.27510
C27	-0.00695	-0.02665	0.03054	0.21543	-0.18582
C28	-0.13558	-0.06467	0.07828	0.01483	-0.32375
C29	-0.05128	0.15914	-0.14943	-0.02440	0.09413
C32	0.12492	0.02040	0.06941	-0.04903	0.05518
C33	0.00970	-0.02088	0.12331	-0.12131	0.05397
C34	-0.00389	0.05338	-0.00735	-0.05215	-0.22302
C58	0.22693	0.00564	-0.06972	-0.08457	-0.18933
C64	-0.49426	-0.30699	0.30858	0.50671	0.10361
C62	0.11965	-0.20237	-0.06068	0.29224	0.45176
C63	-0.00139	0.40782	-0.00517	0.32060	0.20967
C44	-0.18636	-0.13057	0.14894	-0.29045	0.09950
C45	0.10358	0.08133	-0.07640	0.00795	0.07466
C36	0.09697	0.25273	0.13999	0.14903	-0.20294
C37	-0.05341	-0.13559	-0.09057	0.03732	0.23251
C38	0.03113	0.04613	-0.04121	0.11892	-0.12221
C39	0.02265	-0.03824	0.25148	-0.05809	-0.07824
C40	-0.27709	-0.23324	-0.00522	-0.27814	-0.03940
C53	0.16977	0.18888	-0.12836	0.22392	-0.17850
C54	0.07011	-0.18571	-0.26768	0.24170	0.12700
C55	0.03535	0.16586	0.20400	-0.10545	0.12019
C56	0.16947	0.26040	0.01571	0.27860	-0.20590
C57	-0.03551	0.33111	0.14753	0.05069	0.18156
C59	0.29064	0.22279	0.02078	-0.45414	-0.02608
C61	-0.05972	0.38208	0.07263	0.09336	0.13505
C48	0.24770	-0.22453	0.06401	0.32573	-0.66077
C50	-0.05583	0.05453	0.11401	-0.17736	0.03443
C51	-0.13513	0.09447	0.26720	-0.39000	0.22758
C52	0.06306	-0.04435	0.07170	-0.03667	-0.00759
C421	0.02401	0.01391	-0.55733	0.08965	-0.17928
C431	0.32080	-0.05876	-0.04170	0.02137	0.14580
C461	-0.14959	0.02436	-0.72697	0.04724	0.19965
C471	0.70088	-0.46049	0.22459	0.02826	0.19183

the six discriminant functions are given in Table 9.2.1, the canonical discriminant functions evaluared as group means are given in Table 9.2.1, and a plot of the group centroids against the first three discriminant functions is shown in Figure 9.2.1.

The ordination obtained in this analysis differs from those obtained in sections 5.4.3 and 7.2 in that the indumentum character C471 (SQRT Mean Calyculus Bract Gland Density) had the highest standardized discriminanat function coefficient cn the first function, whereas in the previous analyses this character contributed most to the second function. In this analysis the outer floret characters C61 (Mean Cuter Floret Width) and C63 (Cuter Floret Tube Gland Density) contributed most to the second function, whereas in the previous analyses, it was the disc floret characters C55 (Mean Disc Floret Corolla Length), C56 (Mean Disc Floret Corolla Width), and C57 (Max Disc Floret Anther Length) which contributed most highly to the first function. The standardized discriminat function coefficents are shoen in Table 9.2.3.

Using the SPSS DISCRIMINANT classification procedure, 99.82% correct classification of the 543 OTUs was obtained. Only one non-radiate S. vulgaris plant was misclassified as short-rayed S. vulgaris.

Figure 9.2.2 shows the phenogram obtained by UPGMA clustering of the squared euclidean distance of standarized data. The phenogram is similar to the UPGMA phenogram of the material grown under standardized conditions (Figure 7.4.1) in that the radiate and non-radiate *S. vulgaris* cluster together, as do *S. viscosus* and *S.* x *subnebrodensis*. However, it differs from Figure 7.4.1 in that *S. squalidus* rather than *S. sylvaticus* is the last cluster to fuse.

These results show that, despite the envircnmental variation, the character set was still able to distinguish the species.

FIGURE 9.2.1 The group centroids of the species and hybrids sampled frcm the 21 natural populations plotted against the first three discriminant functions.

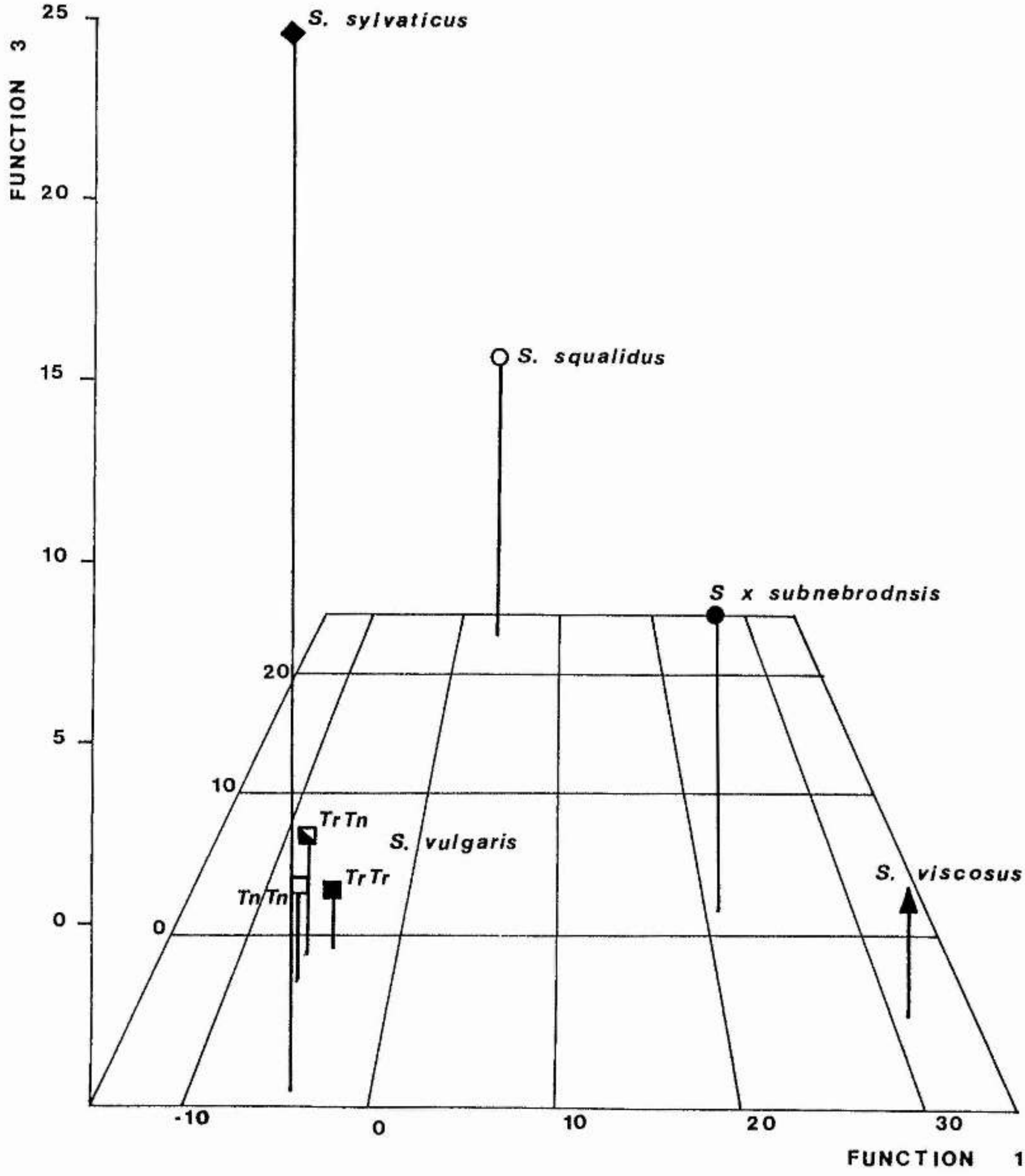


FIGURE 9.2.2 UPGMA phenogram of all OTUs from the 21 natural populations.

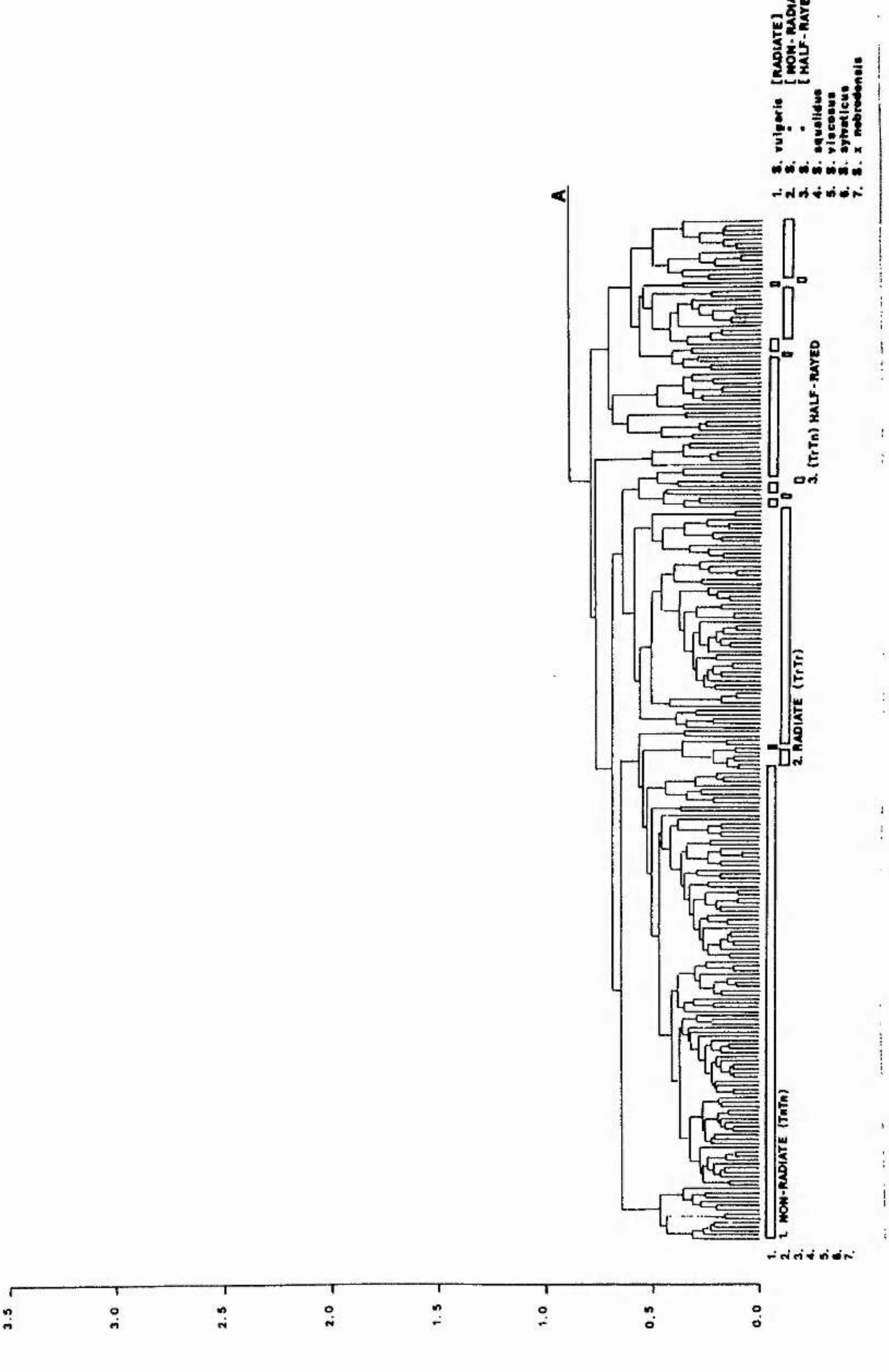
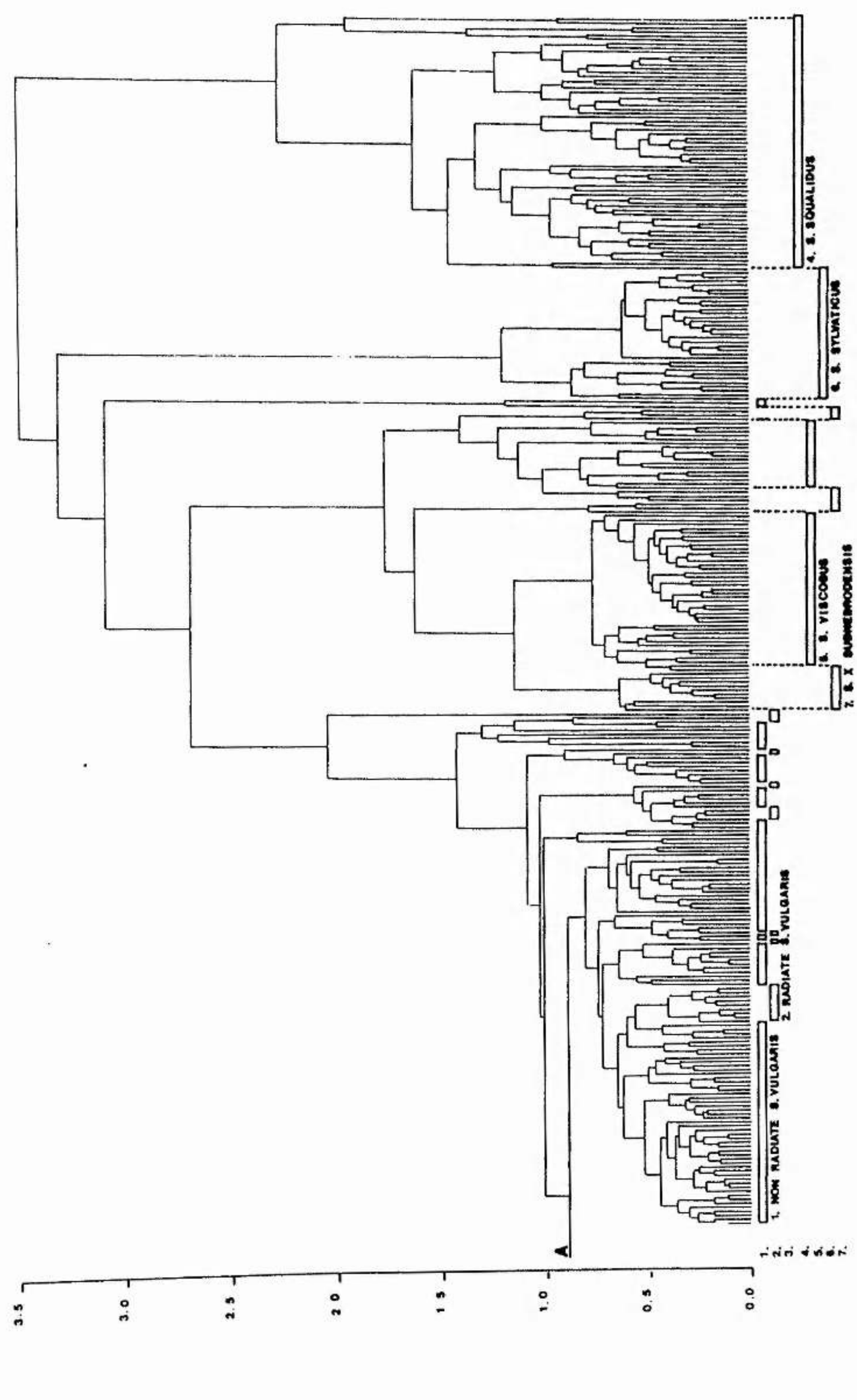


FIGURE 9.2.2 continued.



9.3 Geographic variation in S. vulgaris var. vulgaris.

A discriminant function analysis of the 271 non-radiate S. vulgaris plants from the 21 populations A to U, where the predefined groups were the 21 populations was computed. The eigenvalues, percentages of variance, cumulative percentages of variance, and the canonical correlations of the first ten of the 20 discriminant functions are given in Table 9.3.1. The standardized discriminant function coefficients are given in Table 9.3.2, and the values of the group centroids of the 21 populations on the first five discriminant functions are given in Table 9.3.3

TABLE 9.3.1 Eigenvalues, percentages of variance, cumulative percentages of variance, and canonical correlations of the first ten discriminant functions.

Function	Eigenvalue	% of variance	Cumulative %	Canonical correlation
1	9.7258	30.46	30.46	0.9522
2	4.6609	14.60	45.06	0.9073
3	3.2143	10.07	55.13	0.8733
4	2.5719	8.06	63.18	0.8485
5	2.0034	6.37	69.45	0.8167
6	1.6979	5.32	74.77	0.7933
7	1.3884	4.35	79.12	0.7624
8	1.1882	3.72	82.84	0.7369
9	1.0127	3.17	86.01	0.7093
10	0.9025	2.83	88.84	0.6887

TABLE 9.3.2 Standardized canonical discriminant function coefficients.

	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
C02	0.01083	0.42256	-0.63558	-0.30258	0.10136
C03	-0.00488	-0.16038	-0.01018	0.22538	0.13890
C04	0.10564	-0.49777	-0.42071	-0.15073	-0.30430
C05	0.18926	0.20707	-0.37503	-0.10447	0.22954
C06	-0.15572	-0.38299	0.52718	0.43334	-0.43030
C07	0.22807	0.35304	-0.46015	-0.35728	0.00358
C08	0.30820	-0.33342	-0.07032	0.32194	0.04947
C09	-0.21313	-0.01104	0.20916	0.32568	0.31664
C101	0.19310	0.03963	-0.52758	-0.12651	0.25425
C121	-0.10680	-0.15614	0.26966	-0.41878	-0.11280
C14	0.33154	0.90283	-0.28114	0.01024	-0.18718
C15	-0.44571	-0.60579	0.22471	0.10485	0.10692
C18	0.09502	0.11231	0.06502	-0.16165	-0.41719
C16	0.00605	-0.09926	0.35151	0.04958	0.20910
C20	0.07244	-0.47823	0.65755	-0.33470	-0.09426
C21	0.07912	0.21134	0.16927	0.76068	-0.27718
C22	-0.00724	0.08163	0.02102	0.11545	-0.08465
C23	-0.22554	0.08780	0.20403	-0.28388	-0.10073
C24	-0.09231	0.32527	0.11357	0.08583	-0.04613
C25	-0.12056	-0.23747	-0.24204	-0.68017	-0.27054
C26	-0.14178	-0.06725	0.01167	0.31943	0.08534
C27	-0.23004	0.32266	-0.36382	0.19030	0.30606
C28	0.08034	-0.20332	-0.18133	0.06101	0.13842
C29	0.12468	0.15781	-0.00022	-0.57321	0.33925
C31	-0.09656	0.12404	0.20546	0.02998	-0.23854
C32	0.23516	0.14453	0.23134	0.38038	-0.20948
C33	-0.00071	-0.00898	-0.23490	0.42818	0.03025
C34	-0.00562	-0.14881	0.01039	0.10020	0.22834
C58	-0.16154	0.22343	-0.01737	0.09164	-0.07966
C44	-0.06300	-0.17017	0.08986	0.26841	0.18883
C45	-0.09243	-0.14888	0.08153	-0.08615	0.03862
C35	0.15462	-0.08252	-0.09349	0.01005	0.27169
C36	-0.06841	-0.04553	0.03173	-0.16788	0.41290
C37	-0.39597	-0.01027	0.20533	0.28021	-0.58703
C38	0.35385	0.08829	-0.11581	0.05271	0.26080
C40	0.16674	0.03077	0.13192	-0.10361	-0.02954
C53	-0.18659	0.17227	0.07437	-0.04930	0.11061
C54	0.02468	0.14072	0.00221	-0.04331	-0.30633
C55	0.18262	0.17412	0.03098	0.10200	0.08504
C56	0.05020	-0.00255	-0.16924	-0.02013	0.18015
C57	0.23267	-0.07642	-0.03744	0.08722	-0.26571
C59	0.33112	0.37335	-0.14130	0.12740	0.06520
C61	-0.07602	0.00923	0.22148	0.01214	-0.05162
C48	0.28547	-0.01118	0.25965	-0.06686	0.21267
C50	0.10166	-0.16738	-0.00057	-0.54397	-0.51393
C51	-0.14401	0.28992	0.28395	-0.43422	-0.02431
C52	-0.35009	-0.05600	-0.13555	0.23866	0.22701
C421	0.11804	0.03989	0.20412	0.11123	-0.12505
C431	0.29436	-0.44768	-0.22644	-0.07838	0.28674
C461	-0.07473	0.09331	-0.04450	-0.21214	-0.03793
C471	0.16067	-0.02541	0.04751	-0.00605	-0.07380

TABLE 9.3.3 Canonical discriminant functions evaluated at group means (group centroids).

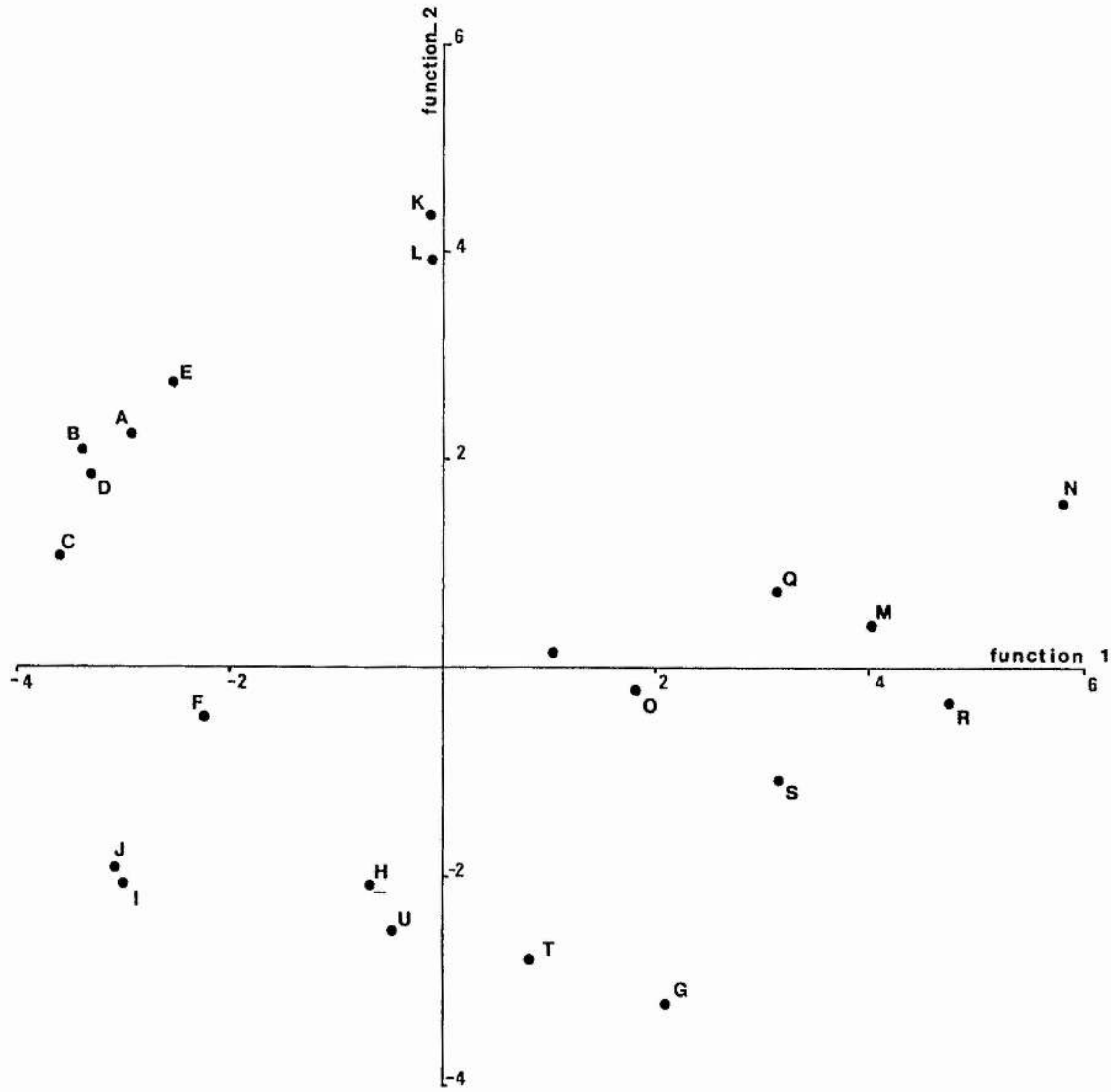
POPN.	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
A	-2.94261	2.25081	-2.68344	-0.59652	-0.12086
B	-3.42833	2.15932	-1.33951	0.36274	-0.46635
C	-3.59295	1.07877	-2.11016	0.94931	-0.61250
D	-3.35092	1.84990	-2.22035	0.86897	-0.26544
E	-2.57677	2.74265	4.51186	0.58851	2.26584
F	-2.25501	-0.50939	0.76857	-0.13592	-0.47028
G	2.11336	-3.23124	-1.74149	-2.56199	1.65042
H	-0.67051	-2.12733	-1.40231	1.79487	3.06489
I	-3.00330	-2.04278	-0.00354	0.18159	-0.61004
J	-3.09072	-1.88010	0.44094	-0.01198	-1.35067
K	-0.14825	4.33660	-1.78826	-2.98206	-0.18000
L	-0.09455	3.90096	-1.11009	-1.11979	1.52582
M	4.01344	1.37726	0.87863	-0.34134	-1.37776
N	5.78216	1.60316	0.29764	1.15620	-0.97246
O	1.79469	-0.26030	1.79661	-0.33040	-2.24546
P	0.99512	0.18310	2.14715	-2.03986	-1.94754
Q	3.12305	0.76393	-1.23486	5.46227	-0.51963
R	4.71495	-0.32597	-0.92116	-0.62552	1.52040
S	3.20014	-1.03899	-1.02652	-2.22543	1.36818
T	0.78479	-2.75848	0.24627	0.26885	1.02701
U	-0.51027	-2.53785	0.12710	-0.59749	-0.11421

The stepwise method excluded six characters; C17 (MLF Apical Lobe Length), C39 (Number of Phyllaries), C49 (Range of Calyculus Bract Length), C62 (Outer Floret Ray Gland Density), C63 (Outer Floret Tube Gland Density), and C64 (Outer Floret Anther Development). The latter three characters are invariant within non-radiate S. vulgaris, there was complete absence of glands on the outer florets, and there was always full development of the anthers.

The characters which had the highest standardized coefficients on the first discriminant function were C15 (MLF Auricle Width) at -0.44571, C37 (Capitulum Base Width) at -0.39597, C38 (Pedicel Length) at 0.35385, C52 (Calyculus Bract Max Black Tip Length) at -0.35009, and C14 (MLF Auricle Length) at 0.33154. The characters which had the highest standardized coefficients on the second function were C14 (MLF Auricle Length) at 0.90283, C15 (MLF Auricle Width) at -0.60579, C04 (Number of Internodes) at 0.42256, and C431 (SQRT Max Phyllary Gland Density) at -0.44768.

Figure 9.3.1 shows a plot of the group centroids against the first two discriminant functions. In this figure nine of the ten populations of the northern transect (populations A to J) have negative scores on the first function, as do the two monomorphic populations on the southern transect (populations K and L). Eight of the nine polymorphic populations had positive scores on the first discriminant function. It can also be seen that the populations from the eastern ends of the transects tend to have higher scores on the second discriminant function

FIGURE 9.3.1 Plot of the group centroids of the 21 S. vulgaris var. vulgaris populations (A to U) against the first two dicriminant functions.



than the western populations, i.e., the scores for populations A to E are higher than those of G to J, and the scores of populations M to R are higher than those of populations S to U.

Figure 9.3.2a shows the discriminant function scores of the group centroids on the first function plotted on a map of central Scotland showing the location of the 21 populations. Figure 9.3.2b shows the group centroid scores on the second function plotted against the population locations.

From Figure 9.3.2a it can be seen that the northern monomorphic populations tend to have negative first function scores, whereas the southern polymorphic populations tend to have positive first function scores. That is, the first discriminant function separates the populations geographically, and this separation is geographically correlated with the distribution of radiate S. vulgaris. Only one of the northern populations, population G, has a positive score on the first function, and only one of the southern populations, population U, has a negative score on the first discriminant function.

From Figure 9.3.2b it can be seen that the populations are separated into two geographical areas by the second discriminant function scores. The eastern populations have positive scores, and the western populations have negative scores. The only exception to this is population O, which is an Edinburgh population, but which has a negative score.

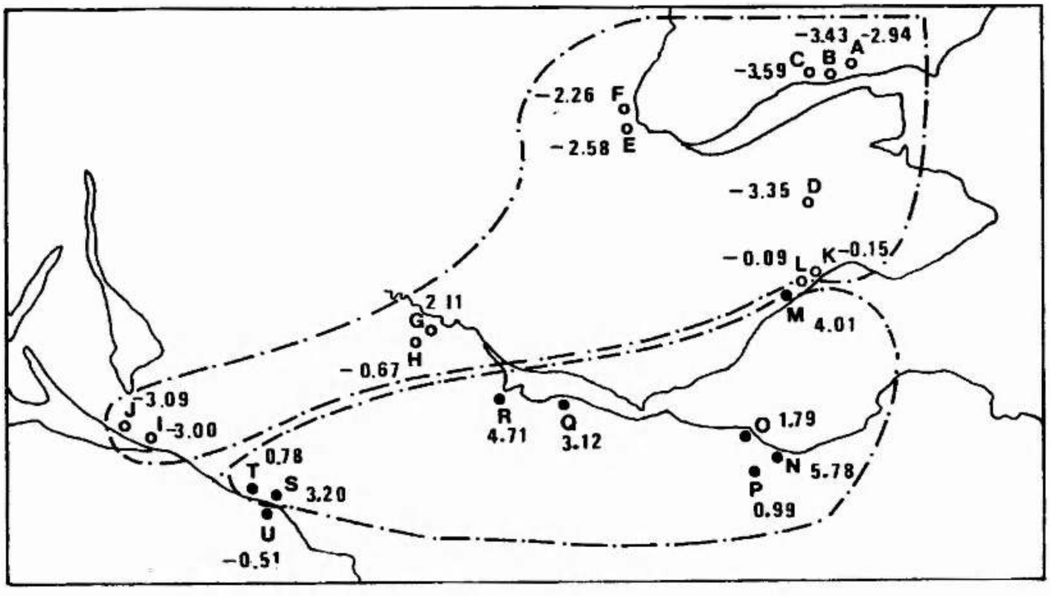


FIGURE 9.3.2a The first discriminant function scores of the 21 S. vulgaris var. vulgaris populations mapped against the geographic location of the population.

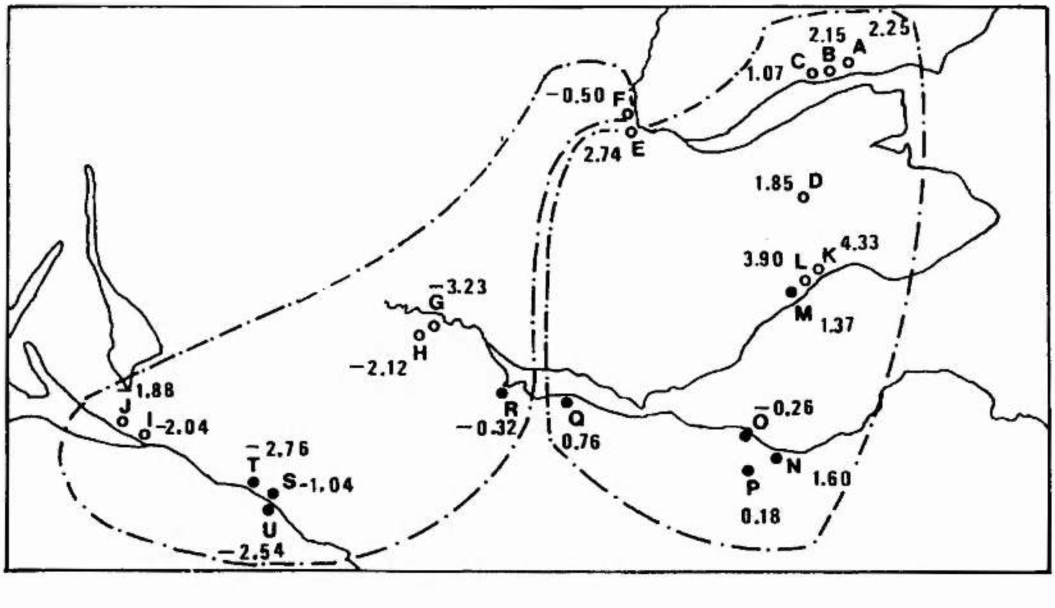


FIGURE 9.3.2b. The second discriminant function scores of the 21 S. vulgaris var. vulgaris populations mapped against the geographic location of the population.

9.4 Geographic variation in S. vulgaris var. hibernicus.

A discriminant function analysis of the 97 radiate S. vulgaris plants was computed using the same method as the previous analysis. The eigenvalues, percentages of variance, cumulative percentages of variance, and the canonical correlations for the six discriminant functions are given in Table 9.4.1.

The stepwise method excluded 18 characters from the analysis; C03 (Inflorescence Length), C04 (Number of Internodes), C101 (MLF Total Max Width), C14 (MLF Auricle Length), C22 (MLF Mid-Lobe PV to Max Width), C28 (MLF Intercostal Length A), C33 (MLF Basal Angle B), C35 (Capitulum Total Length), C40 (Maximum Phyllary Length), C45 (Number of Pedicel Bracts), C49 (Range of Calyculus Bract Length), C50 (Mean Calyculus Bract Width), C55 (Mean Disc Floret Corolla Length), C59 (Mean Outer Floret Length), C61 (Mean Outer Floret Width), C62 (Mean Outer Floret Ray Gland Density), C63 (Mean Outer Floret Tube Gland Density), and C471 (SQRT Mean Calyculus Bract Gland Density).

Function	Eigenvalue	% variation	Cumulative %	Canonical corelation
1	16.5675	46.41	46.41	0.9711
2	8.0763	22.62	69.03	0.9433
3	5.5179	15.46	84.48	0.9200
4	2.5201	7.06	91.55	0.8461
5	2.1670	6.07	97.62	0.8271
6	0.8506	2.38	100.00	0.6779

TABLE 9.4.1 Eigenvalues, percentages of variance, cumulative percentages of variance, and canonical correlations of the six discriminant functions.

TABLE 9.4.2 Standardized canonical discriminant function coefficients.

	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
C02	-0.49555	0.46693	0.60904	0.44931	0.19735
C05	-0.55760	0.29426	0.01546	-0.13983	-0.01452
C06	0.49392	0.30489	0.24699	0.84191	-0.33914
C07	-0.96639	-0.40312	0.05540	-0.75570	0.46287
C08	0.68976	0.92235	0.44615	0.82922	0.10901
C09	-1.18603	-1.98395	-0.26437	-0.79938	0.59462
121	0.88768	1.22106	0.11704	0.25849	-1.08345
C15	-0.44563	-0.47140	0.70438	-0.23743	-0.58745
C17	-0.01521	1.29077	-0.96828	-0.28482	-0.24346
C18	-0.43363	-1.81186	0.49541	0.86006	0.00974
C16	0.20281	0.10339	-0.04024	0.63952	-0.26930
C20	1.30234	0.46179	-0.00209	-1.51755	1.59018
C21	-0.82259	1.05877	-0.59362	0.94987	-0.98647
C23	-0.21708	-0.75014	-0.88736	-0.76889	0.05026
C24	0.15799	-0.54369	0.26941	-0.21002	-0.15387
C25	0.79530	-0.38275	0.05054	0.39027	0.30660
C26	0.88421	1.03843	0.54871	-0.10622	-0.28766
C27	-0.46979	0.10124	0.49114	0.76081	0.57138
C29	-0.08055	-0.64224	-0.11498	0.09760	0.04991
C31	-0.29794	-0.07095	0.06162	-0.39035	0.03673
C32	0.46986	0.88047	0.03223	0.43344	-0.03938
C34	0.29698	0.01662	-0.09066	-0.35169	0.39105
C58	-0.13595	-0.53890	-0.32603	0.15454	-0.09192
C64	0.44431	-0.14917	0.02651	-0.09736	0.17459
C44	0.07254	0.05941	-0.50028	-0.16063	0.00589
C36	0.72136	0.12477	-0.34730	-0.16914	0.20863
C37	-0.40913	0.66934	0.09338	0.20313	-0.01107
C38	-0.41172	-0.27885	-0.09167	0.13886	0.71868
C39	-0.42340	0.02538	0.28293	0.21543	-0.10714
C53	0.57260	-0.73417	0.58204	0.09771	-0.23159
C54	0.49843	0.00443	0.03623	0.10006	-0.32190
C56	-0.27788	-0.06379	-0.28658	0.14163	-0.25571
C57	-0.89068	0.23311	-0.32781	0.11015	-0.35327
C48	-0.53573	-0.41390	0.13403	-0.08787	0.30206
C51	-0.12607	0.35770	0.06860	-0.24270	-0.25558
C52	0.05676	0.18405	0.52150	0.04009	-0.24125
C421	0.14109	-0.06514	0.17809	0.31778	0.64773
C431	0.62484	0.28512	-0.52777	-0.09275	-0.12276
C461	0.36822	-0.57740	-0.49223	-0.15893	-0.23634

TABLE 9.4.3 Canonical discriminant functions evaluated at group means (group centroids).

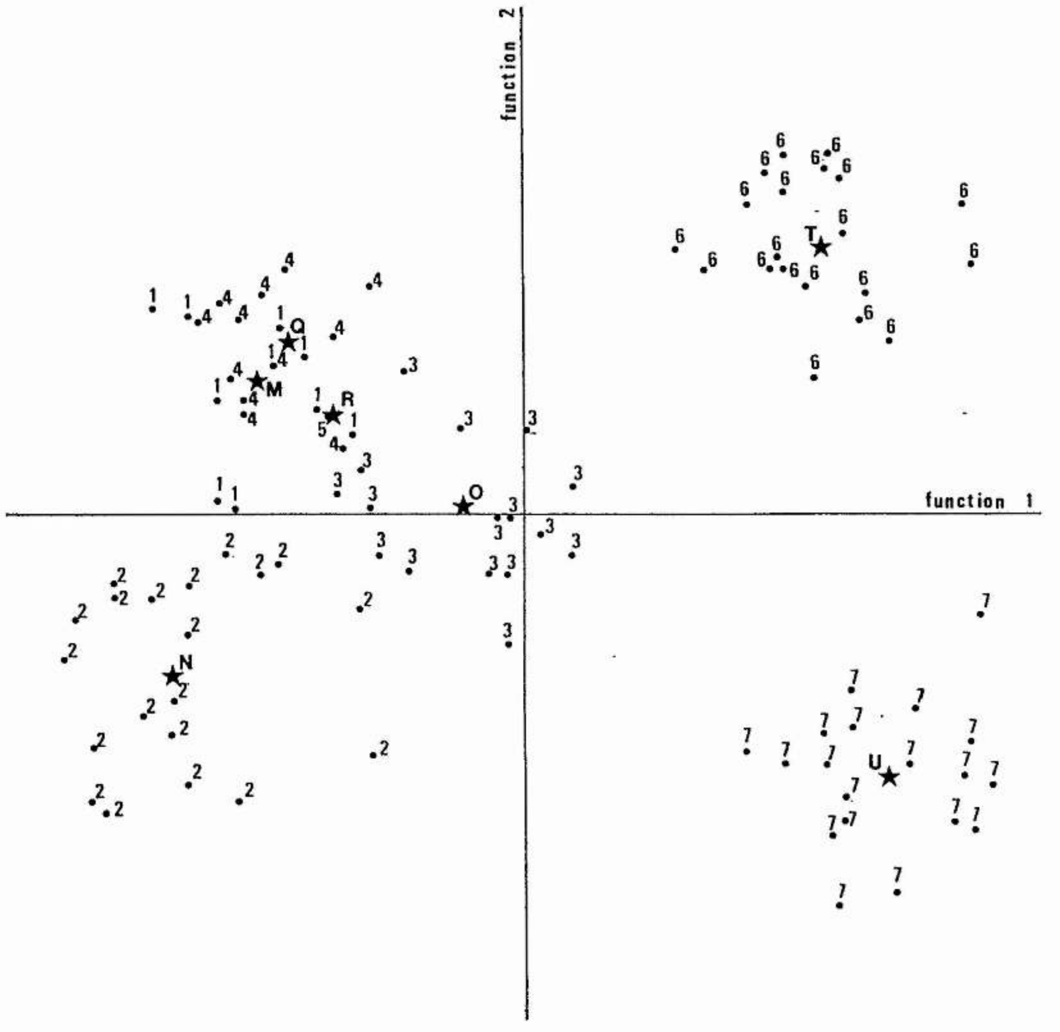
POPN	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
M	-3.65265	1.76745	4.83882	2.56991	0.18364
N	-4.75343	-2.26484	-2.23860	0.35963	1.35509
O	-0.85498	-0.11265	-1.39544	0.37362	-2.90703
Q	-3.34617	2.34775	1.80582	-3.70703	-0.02240
R	-2.66709	1.34698	2.01152	-3.36075	0.78907
T	3.95942	3.73841	-1.61533	0.46179	0.85581
U	4.91584	-3.61601	1.50523	-0.38441	0.20775

A can be seen from table 9.4.2 the characters with the highest standardized coefficients on the first discriminant function were C20 (MLF Mid-lobe Length) at 1.30234, C09 (Midleaf Length) at -1.18603, C07 (Proportion of Laterals with Capitula) at -0.96639, C57 (Max Disc Floret Anther Length) at -0.89068, and C121 (MLF Mean Base to Max Width Length) at 0.88768. The characters with the highest standardized coefficients on the second discriminant function were; C09 (Midleaf Length) at -1.98395, C18 (MLF Apical Lobe Width) at -1.81186, C17 (MLF Apical Lobe Length) at 1.29077, C121 (MLF Mean Base to Max Width Length), and C21 (MLF Mid-Lobe Max Width A).

Figure 9.4.1 shows the OTUs and the group centroids of the populations plotted against the first two discriminant functions. From this figure it can be seen that the first discriminant function separates the western populations T and U from the eastern populations M, N, O, Q and R. The second discriminant function separates the two western populations T and U, and also separates the eastern population N from the other eastern populations.

Figures 9.4.2a and 9.4.2b show the first and second discriminant function scores plotted on a map of the populations. From these figures it can be seen that the first function separates the populations into two geographical areas, the eastern populations with negative scores, and the western populations with positive scores. The second discriminant function also separates the populations into two areas, the northern populations M. Q, R and T, and the southern populations N, O and U.

FIGURE 9.4.1 Plot of the group centroids (denoted by the symbol *) and the OTUs of the seven S. vulgaris var. hibernicus populations (M to U) against the first two discriminant functions.



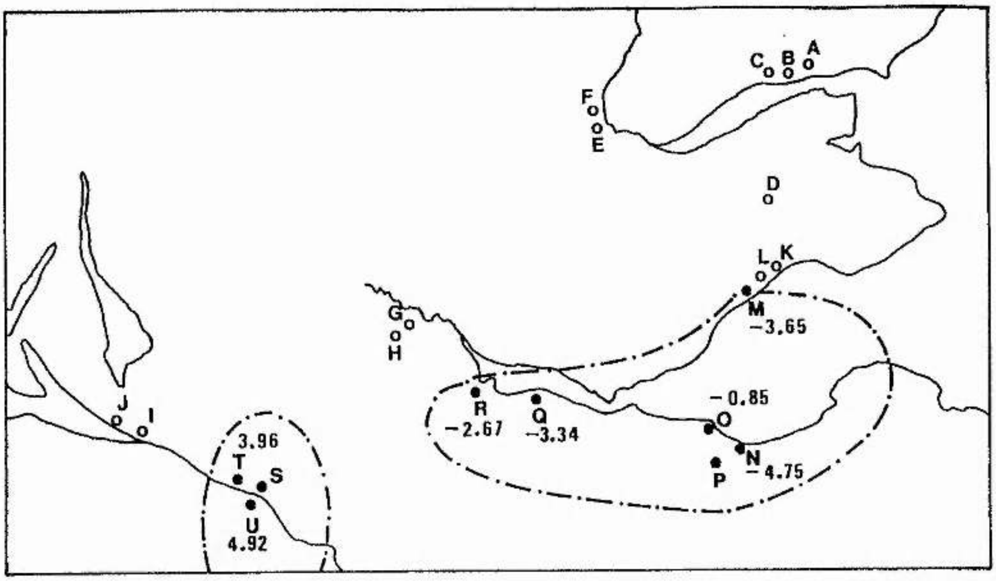


FIGURE 9.4.2a The first discriminant function scores of the seven S. vulgaris var. hibernicus populations mapped against the geographic location of the populations.

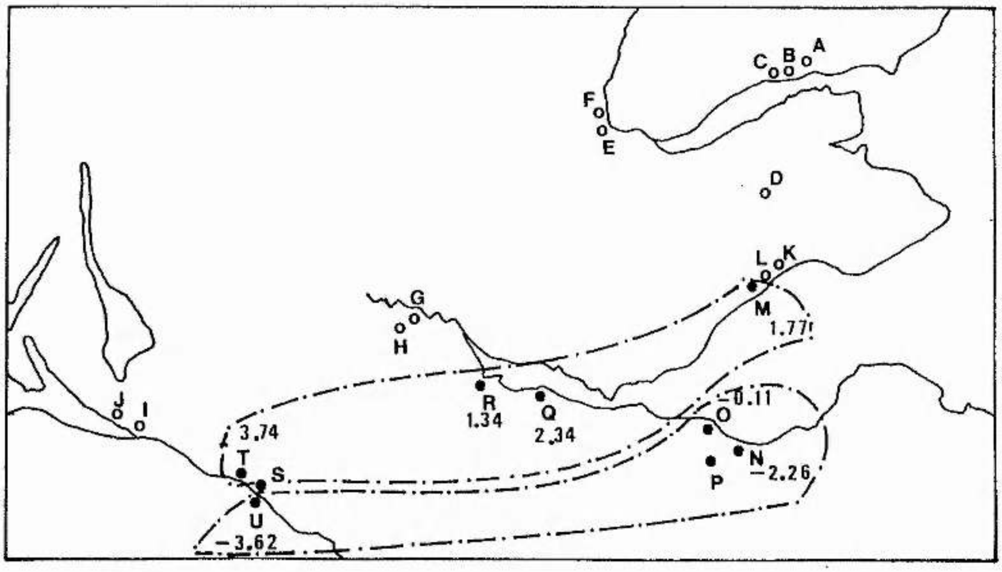


FIGURE 9.4.2b The second discriminant function scores of the seven S. vulgaris var. hibernicus populations mapped against the geographic location of the populations.

9.5 Geographic variation in S.squalidus.

A discriminant function analysis of 62 S. squalidus plants from 8 populations (populations K, L, M, N, O, Q, T and U) was computed using the same methcd as the previous analysis. The eigenvalues, percentages of variance, cumulative percentages, and canonical correlations of the 7 discriminant functions are given in Table 9.5.1.

The stepwise procedure excluded 11 characters from the analysis. These were C03 (Inflorescence Length), C08 (Longest Leaf Length), C121 (MLF Mean Base to Max Width Length), C17 (Apical Lobe Length). C32 (MLF Basal Angle A) C38 (Pedicel Length), C39 (Number of Phyllaries), C431 (SQRT Max Phyllary Gland Density), C45 (Number of Pedicel Bracts), C461 (SQRT Mean Calyculus Bract Hair Density), and C59 (Mean Outer Floret Length).

The character which have the highest standardized coefficients (Table 9.5.2) on the first discriminant function, which accounts for 90.09% of the variance, are C09 (Midleaf Length) at -30.36537, C34 (MLF Secondary Vein Angle) at -17.49152, C14 (MLF Auricle Length) at 16.44605,

TABLE 9.5.1 Eigenvalues, percentages of variance, cumulative percentages of variance, and canonical correlations of the seven discriminant functions.

Function	Eigenvalue	% of variance	Cumulative %	Canonical correlation
1	1107.5641	90.07	90.07	0.9995
2	56.2432	4.57	94.65	0.9912
3	27.6194	2.25	96.89	0.9823
4	14.8773	1.21	98.10	0.9679
5	9.9163	0.81	98.91	0.9530
6	8.1505	0.66	99.57	0.9437
7	5.2395	0.43	100.00	0.9163

TABLE 9.5.2 Standardized canonical discriminant function coefficients.

	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
C02	4.45442	2.03893	0.09964	-0.74734	-0.00919
C04	-1.87837	2.55872	1.73328	-1.07692	-1.24577
C05	2.50055	-2.90459	-2.32724	0.73185	2.07426
C06	9.44507	-0.75532	-1.46185	-0.19248	-1.45223
C07	-7.52802	2.28935	2.64269	-1.68334	-0.48639
C09	-30.36537	-5.39216	2.75825	1.53542	1.45013
C101	7.95046	-5.11773	-6.34909	-0.13850	1.10286
C14	16.44605	-0.83451	-0.02943	-0.68027	-1.54439
C15	-4.18401	0.77252	0.49975	0.80717	0.26207
C18	1.59194	3.53414	-0.04175	0.40932	-1.17708
C16	-2.46296	-0.89940	0.01138	0.51495	1.81820
C20	8.40404	8.54096	6.60331	-6.25759	-3.13671
C21	-2.70790	-0.17209	-1.89658	0.81450	2.56049
C22	-4.33534	1.74341	0.09930	-0.02030	-0.26471
C23	-0.15710	-1.68187	2.13458	0.21971	-1.20551
C24	-4.66508	-6.47502	-3.02939	3.92036	2.36958
C25	11.25136	0.96213	0.82238	0.45459	-2.78581
C26	14.09841	1.07780	-0.73917	-1.27540	-0.85925
C27	2.41158	-1.19126	-3.85186	1.55222	2.84292
C28	9.14962	0.60369	-0.97356	0.85311	1.04870
C29	-14.73384	1.20076	1.18653	-0.01389	-1.58238
C31	-2.13910	-0.46667	0.14845	1.19452	0.00178
C33	8.12706	0.86466	-1.22649	-0.01777	-0.40587
C34	-17.49152	0.31504	3.55531	0.08174	-0.86793
C58	4.94443	0.90217	-0.20271	-0.34210	-0.80368
C64	2.76717	3.04561	-0.03438	0.94590	1.22646
C62	2.94668	0.61888	-0.81620	-0.43660	0.05333
C63	-7.70743	1.50201	1.19506	0.71651	0.27187
C44	-1.91296	-1.72254	-0.85657	0.03809	0.86640
C35	-3.02687	-0.21954	0.24121	-1.07173	-1.59840
C36	-1.51836	-1.50773	1.21786	1.46986	-0.10564
C37	-9.89794	2.11937	0.86197	-0.30285	0.12002
C40	10.97691	-2.21785	-2.39304	-0.62681	0.16249
C53	9.78533	-2.51887	0.72394	0.59265	0.42031
C54	1.32527	-0.35939	-1.88650	0.67607	1.08754
C55	9.62155	-0.34385	1.79715	-0.62639	-0.93291
C56	-4.63339	0.72884	-0.04819	-0.29822	-0.20561
C57	-6.88301	0.00834	2.09108	1.59331	0.03098
C61	5.83675	-0.27057	0.61451	0.51657	0.03151
C48	-1.94533	0.45147	-0.08682	-0.91709	-0.19352
C49	4.53887	-0.06356	0.05649	0.36951	-0.91717
C50	16.24847	0.17087	-3.08927	-0.53974	0.72711
C51	-6.33696	-0.89644	1.04492	0.89458	0.61595
C52	-6.94253	-0.85985	2.05324	0.92159	-0.18100
C421	2.57906	1.14255	-1.34656	0.13513	0.62226
C471	5.55645	0.36508	0.09767	0.28094	1.25842

C50 (Calyculus Bract Width) at 16.24847, C29 (MLF Inter-costal length B) at -14.77384, and C26 (MLF Mid-Lobe Basal Width) at 14.09841. The characters which have the highest standardized coefficients on the second function are C20 (MLF Mid-lobe Length) at 8.54096, C24 (MLF Mid-Lobe PV to Max Width B) at -6.47502, C09 (Midleaf Length) at -5.39216, and C101 (MLF Total Max Width) at -5.11773.

Figure 9.5.1a shows the group centroids of the populations plotted against the first two discriminant functions. Figure 9.5.1b shows the group centroid scores on the first discriminant function plotted against the geographical locations of the populations in central Scotland.

From Figure 9.5.1b it can be seen that there is no obvious geographic pattern to the inter-population variation in S. squalidus. That is, there are no east-west or north-south trends in the discriminant function scores. The three populations which cluster together in Figure 9.5.1a, populations K, N and T, are located, as shown in Figure 9.5.1b, in Leven, Edinburgh and Glasgow respectively.

TABLE 9.5.3 Canonical discriminant functions evaluated as group means (group centroids).

POPN	FUNC 1	FUNC 2	FUNC 3	FUNC 4	FUNC 5
M	-15.71310	-4.99274	14.83715	7.00019	-4.15240
N	-35.23027	13.30953	-0.34735	1.32423	1.88762
O	73.08488	3.99102	5.88835	2.48694	3.96327
P	-15.49838	-5.96336	1.66669	-3.62133	2.15919
Q	8.70287	3.41759	0.50563	-3.26227	-5.39056
R	44.45746	-3.15673	-5.92430	0.57341	-0.32772
T	-17.89033	-6.48008	-5.42284	5.50363	-0.54121
U	23.16642	6.56657	-6.62191	-1.38037	-0.10371

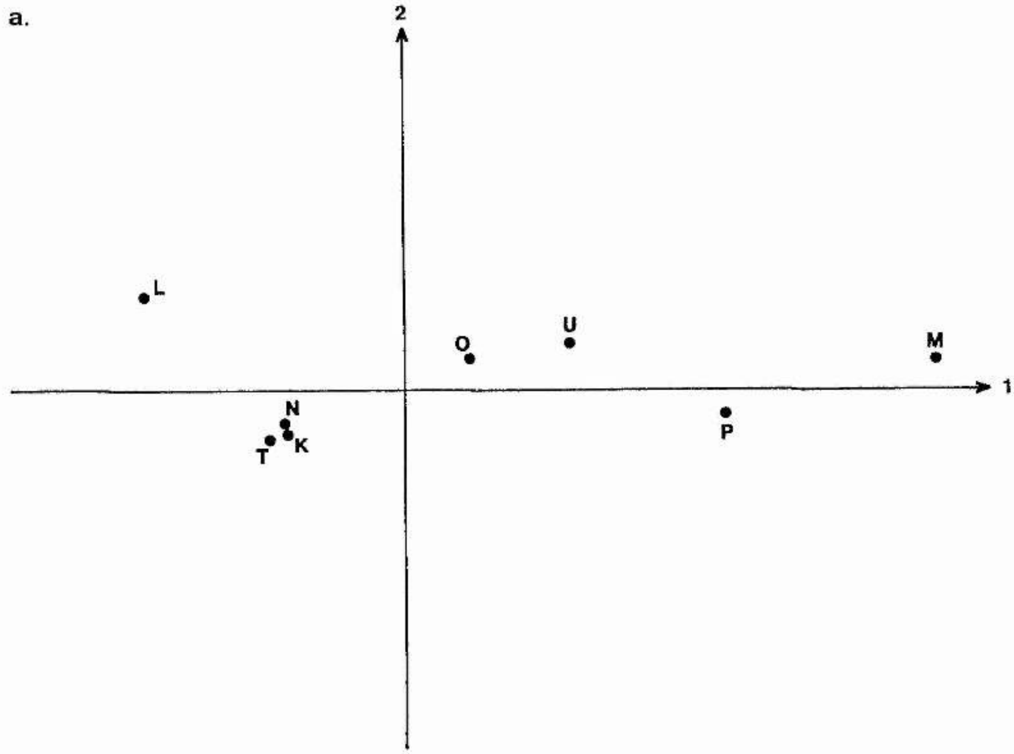


FIGURE 9.5.1a. Plot of the group centroids of the eight S. squalidus populations K to U against the first two discriminant functions.

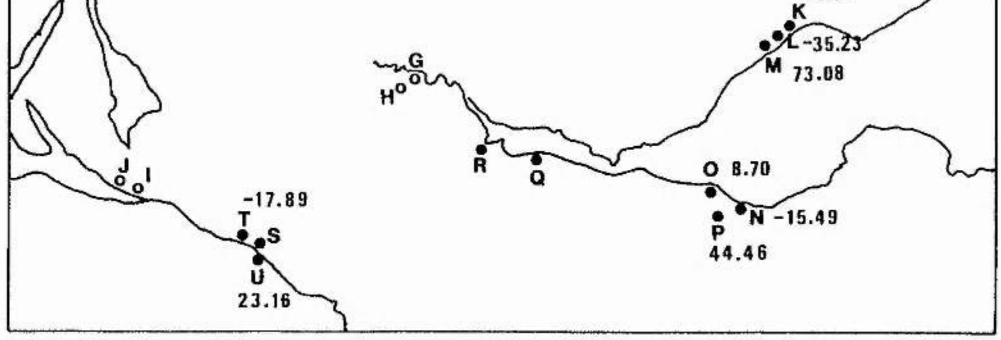


FIGURE 9.5.1b. Plot of the group centroid scores on the first discriminant function against the locations of the population in central Scotland.

9.6 Comparison of geographic variation patterns.

The results of the three previous sections show that both the amount and the direction of the inter-population variation differ in non-radiate S. vulgaris, radiate S. vulgaris and S. squalidus.

In non-radiate S. vulgaris the first discriminant function distinguishes between the monomorphic populations and the polymorphic populations on the basis of both leaf and capitula characters. The monomorphic populations of the northern transect have larger auricles on the middle cauline leaf, wider capitula with shorter pedicels, and wider black tips on the calyculus bracts. The second discriminant function distinguishes between the eastern and the western populations, irrespective of whether or not they are monomorphic or polymorphic. The eastern populations have longer, narrower auricles on the midleaf, and the plants are taller, but have relatively fewer internodes. The western populations have a more glandular indumentum.

In radiate S. vulgaris the midleaf auricle contributes little to the inter-population variation. The first discriminant function separates the western populations form the eastern populations, the western populations having shorter, wider leaves, fewer branches, and a smaller androecium. The second discriminant function subdivides both the eastern and the western populations on the basis of the relative length and width of the leaves, the northern populations in each group having relatively shorter, wider leaves.

In S. squalidus the first discriminant function, which accounts for 90.07% of the variance, is also largely based on the middle cauline leaf characters. However, there are no east-west or north-south trends in the inter-population variation in S. squalidus.

The stepwise method used in these discriminant function analyses excluded different characters from the analyses, only six characters were excluded from the non-radiate S. vulgaris analysis, but 18 were excluded from the radiate S. vulgaris analysis. For this reason, together with the different numbers of populations in the different analyses, the results of these analyses are not directly comparable. However, the results of these analyses indicate that variation in the shape of the middle cauline leaf is responsible for much of the interpopulation variation in radiate and non-radiate S. vulgaris. The geographic variation in leaf shape in both radiate and non-radiate S. vulgaris is further examined in the next section.

9.7 Geographic variation in leaf shape in *S. vulgaris*.

Figure 9.7.1 illustrates the range of leaf shapes found in *S. vulgaris* var. *vulgaris*. The three leaves at the top (1,2 and 3) are from plants of populations A, E and I respectively. That is they are from monomorphic populations in the northern transect. The three leaves in the lower row (4,5 and 6), are from populations M, N and S, which are popymorphic populations from the southern transect.

Figure 9.7.2 illustrates the range of leaf shapes found in *S. vulgaris* var. *hibernicus*. The two leaves at the top are from the western part of the transect, the two leaves in the lower row are from populations in the eastern part of the transect.

From these figures it can be seen that the leaf shapes of radiate and non-radiate *S. vulgaris* are distinct. A discriminant function analysis of the two varieties on the basis of the 22 midleaf characters gives a single discriminant function with an eigenvalue of 1.32328. The classification procedure gave 10.7% misclassification of non-radiate plants as radiate, and 7.2% misclassification of radiate as non-radiate plants. That is, over 90% of the plants from natural population were correctly classified as either radiate or non-radiate *S. vulgaris* on the basis of leaf shape.

A principal component analysis of the 368 *S. vulgaris* plants using the 22 midleaf characters was computed using the same method as in the previous two sections.

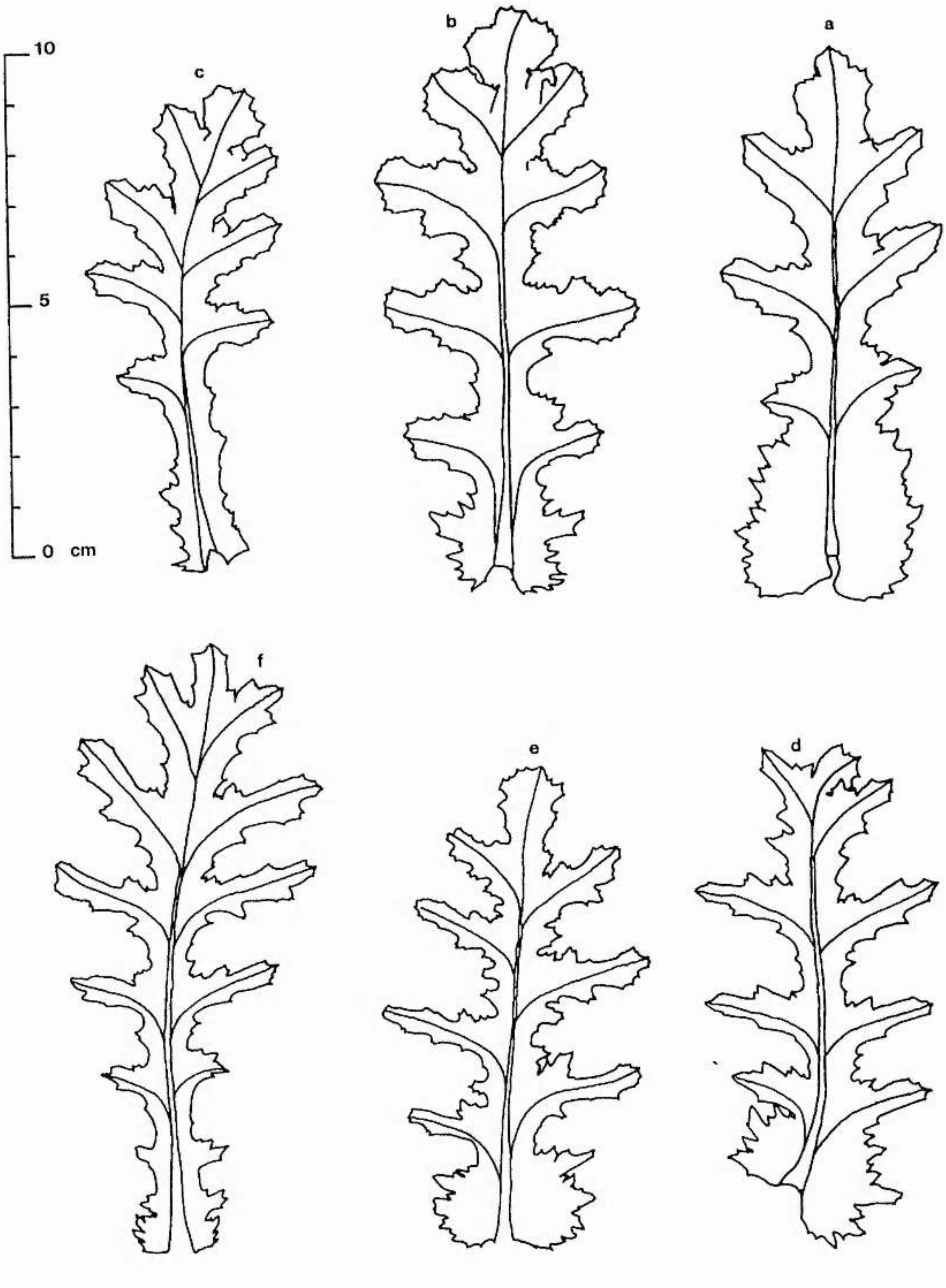


FIGURE 9.7.1 Illustrating the range cf leaf shapes fcund in S. vulgaris var. vulgaris, (a) from population A (Dundee), (b) from population E (Perth), (c) from population I (Dumbarton), (d) from population M (Methil), (e) from population N (Edinburgh), and 8f) from population S (Glasgow).

TABLE 9.7.1. Eigenvalues. percentages of variance. and cumulative percentages of variance of the first 10 principal components.

Function	Eigenvalue	% of variance	Cumulative %
1	10.26	30.16	30.16
2	5.39	15.86	46.02
3	3.29	9.67	55.69
4	1.95	5.73	61.43
5	1.32	3.89	65.32
6	1.24	3.63	68.95
7	1.12	3.29	72.24
8	0.97	2.86	75.10
9	0.91	2.68	77.77
10	0.84	2.47	80.25

The first principal component was largely a size factor, the longest leaves having high positive scores on the first component axis.

Figure 9.7.3 shows a plot of the OTUs against the second and third principal component axes. In this figure the non-radiate plants are identified by lower case letters, the radiate plants by capitals. The letters correspond to the populations A to U. From this figure it can be seen than the S. vulgaris leaves form four clusters, and separated primarily on the basis of the factor scores on the second principal component. The outlines of the clusters are shown in Figure 9.7.4.

The first cluster, with high negative scores on the second principal component, comprises non-radiate plants from the populations A to D. The second cluster, with low negative scores on the second principal component, comprises non-radiate plants from populations E to J. The third cluster, with low positive scores on the second pricipal component, comprises non-radiate plants from populations M to U. The fourth cluster, with high positive

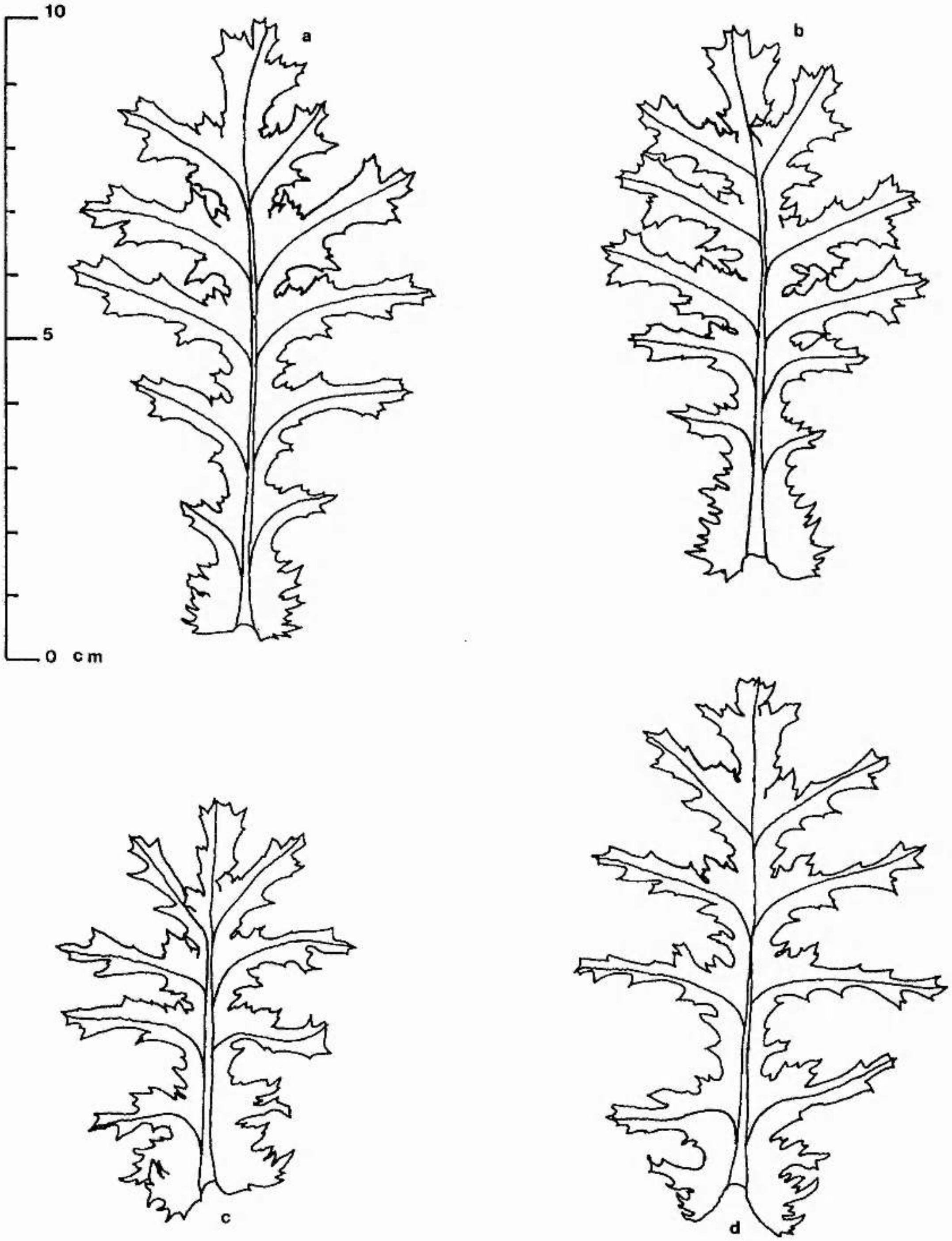
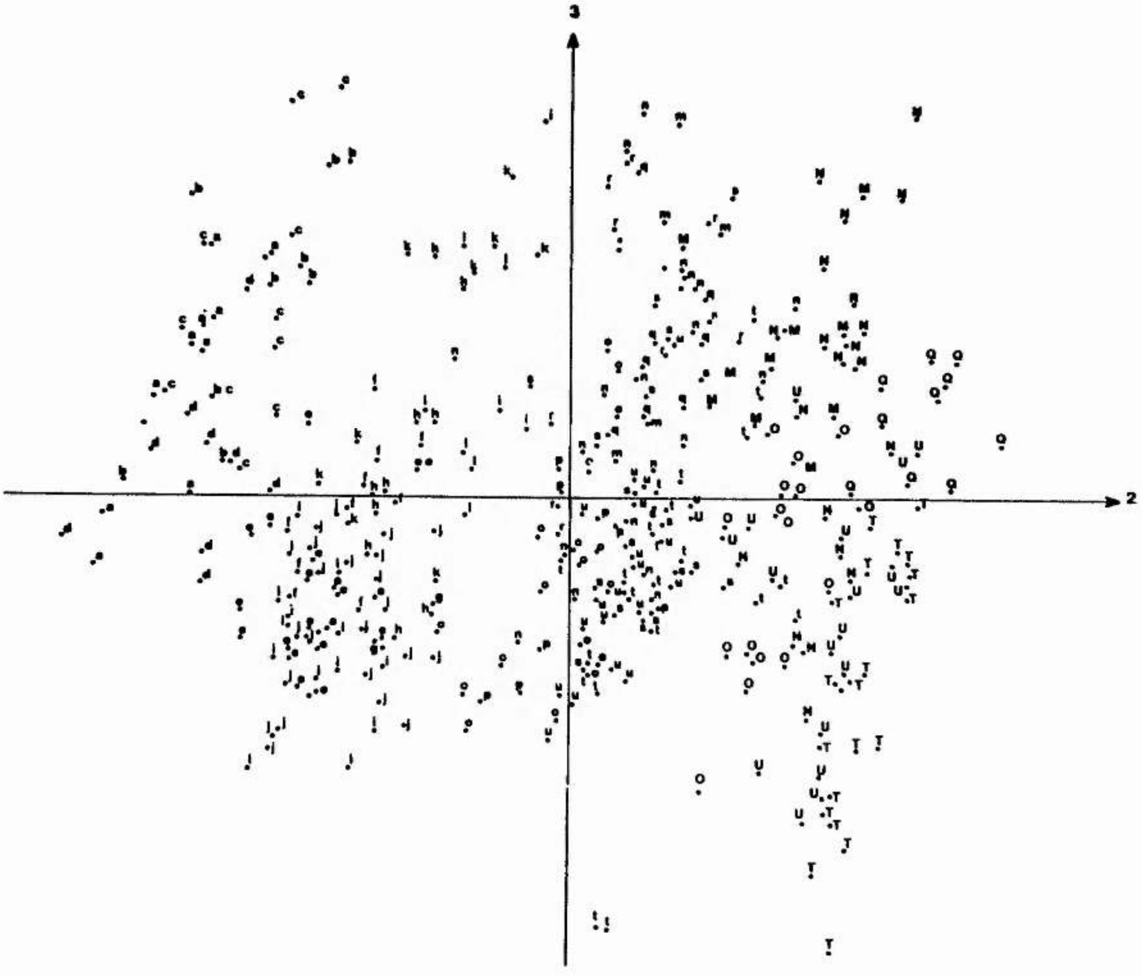


FIGURE 9.7.2 Illustrating the range of leaf shapes found in S. vulgaris var. hibernicus, (a) from population U (Glasgow), (b) from population S (glasgow), (c) from population Q (Boness), and (d) from population O (Edinburgh).

scores on the second principal component, comprises the radiate plants from populations M to U. Of these four clusters, the first three, which contain the non-radiate OTUs, show only slight overlapping between the second and third clusters. The third and fourth clusters which contain the non-radiate and radiate OTUs of populations M to U, the polymorphic populations, show considerably more overlap.

From Figure 9.7.3 it can be seen that there is some subdivision of clusters 2, 3 and 4. In the second cluster the OTUs of populations K and L have higher scores on the third principal component than the OTUs of populations E, F, G, H, I and J. In the third and fourth clusters the OTUS of populations M, N, Q and R have higher scores on the third axis than the OTUs of populations C, P, T and U. This subdivision of the clusters appears to be correlated with the longitude of the sites. The eastern populations A, B, C, D, K, L, M, N, Q, and R have positive scores on the third principal component, and the western populations E, F, G, H, I, J, U and T have negative scores. The OTUs of populations O and S, however, show considerable scattering along the third component axis. Figure 9.7.4b shows the positions of the three non-radiate clusters mapped against the geographic location of the populations in central Scotland. The fourth cluster, the radiate OTUs, has the same geographic location as the third cluster.

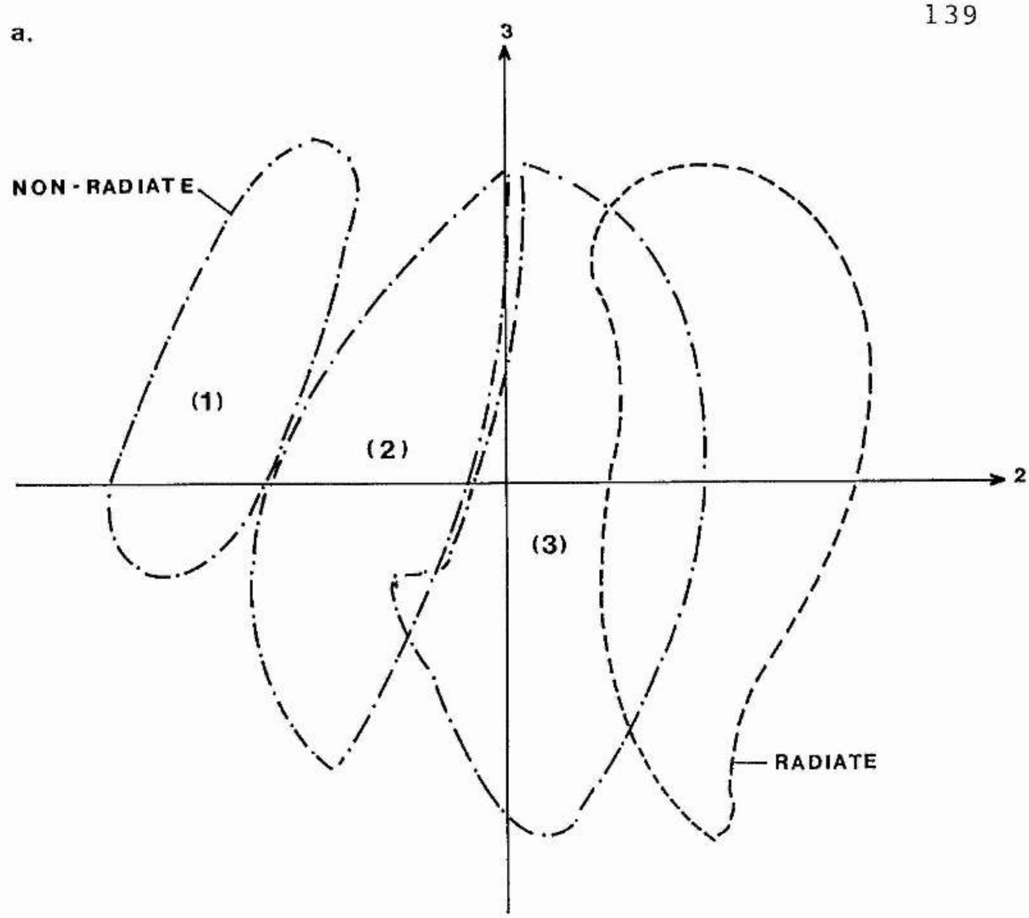
FIGURE 9.7.3 Plot of the OTUs of the radiate and non-radiate leaves against the the second and third principal component axes. The non-radiate leaves are denoted by lower case letters, the radiate leaves by capital letters.



The population which showed the greatest degree of overlap between the radiate and non-radiate OTUs in Figure 9.7.3 was population N (Edinburgh, Salamander Street). Figure 9.7.5 illustrates the range of leaf shapes found in non-radiate S. vulgaris at this site, and, from this figure, it can be seen that some of the plants, e.g., OTU Nos. 11401 and 11413, have leaf shapes which are more like S. vulgaris var. hibernicus (as shown in Figure 9.7.2) than S. vulgaris var. vulgaris (as shown in Figure 9.7.1). Other leaf shapes, e.g., OTU No. 11414 in Figure 9.7.5, are intermediate between the typical non-radiate and radiate shapes.

These intermediate leaf shapes suggest that hybrization may occur between the radiate and non-radiate morphs in this population. This population did have the highest frequency of short-rayed heterozygotes. In section 8 it was shown that in hybrids between S. vulgaris x S. squalidus there was a reduction in correlation between the midleaf characters. Therefore, if a similar reduction in the character correlation was found in the OTUs of the polymorphic populations, this would suggest that the variation in leaf shape at these populations is the result of inter-varietal hybridization.

The correlations between the 22 midleaf characters in the radiate and non-radiate OTUs of populations N and T, and the non-radiate OTUs of population J, a momomorphic population were compared. Histograms of the distribution of the product-moment correlation coefficients of the five



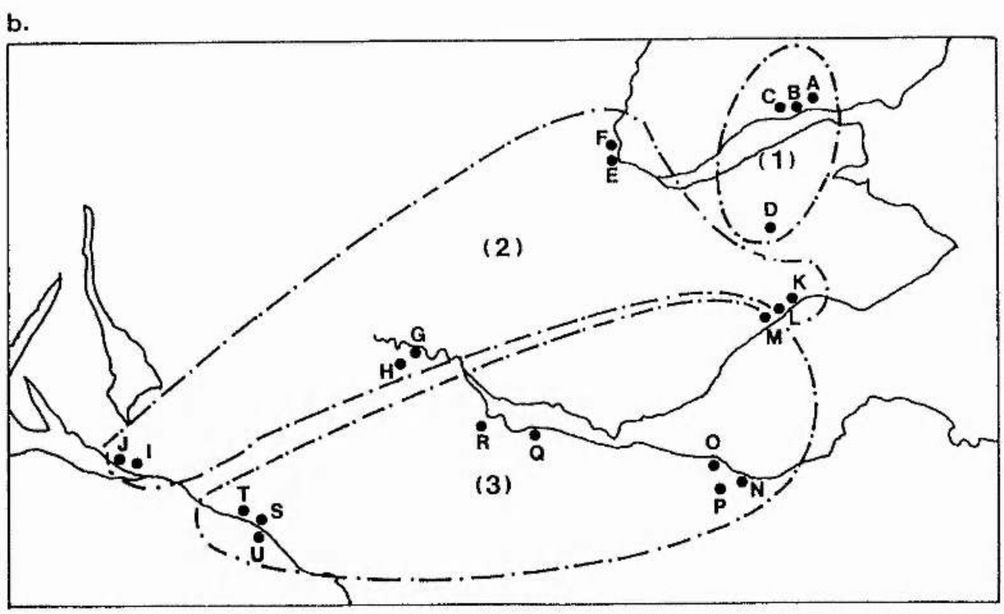


FIGURE 9.7.4. Showing (a) the outlines of the four clusters of the S. vulgaris leaf OTUs when plotted against the second and third principal component axes, where (1) is the non-radiate leaves from populations A to D, (2) is the non-radiate leaves from populations E to L, (3) is the non-radiate leaves from populations M to U, and (4) is the radiate leaves from populations M to , and (b) showing these groups mapped against their geographic locations.

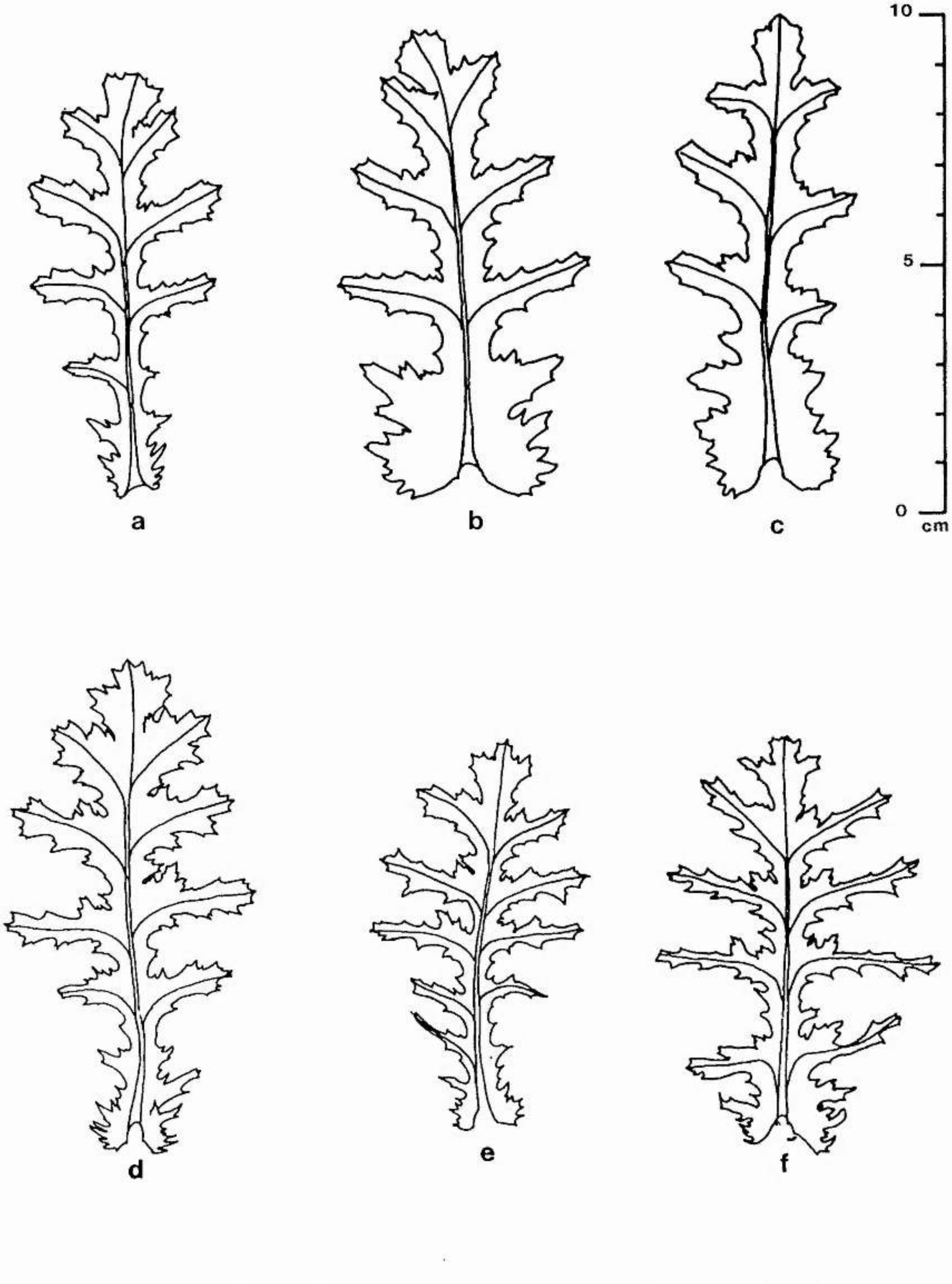


FIGURE 9.7.5 Illustrates the range of leaf shapes of _S. vulgaris_ var. _vulgaris_ found at population N (Salamander St., Edinburgh). These leaf shapes range from typical non-radiate shapes (c) OTU No. 11417 and (b) OTU No. 11406, to typical radiate leaf shapes such as (f) OTU No. 11413.

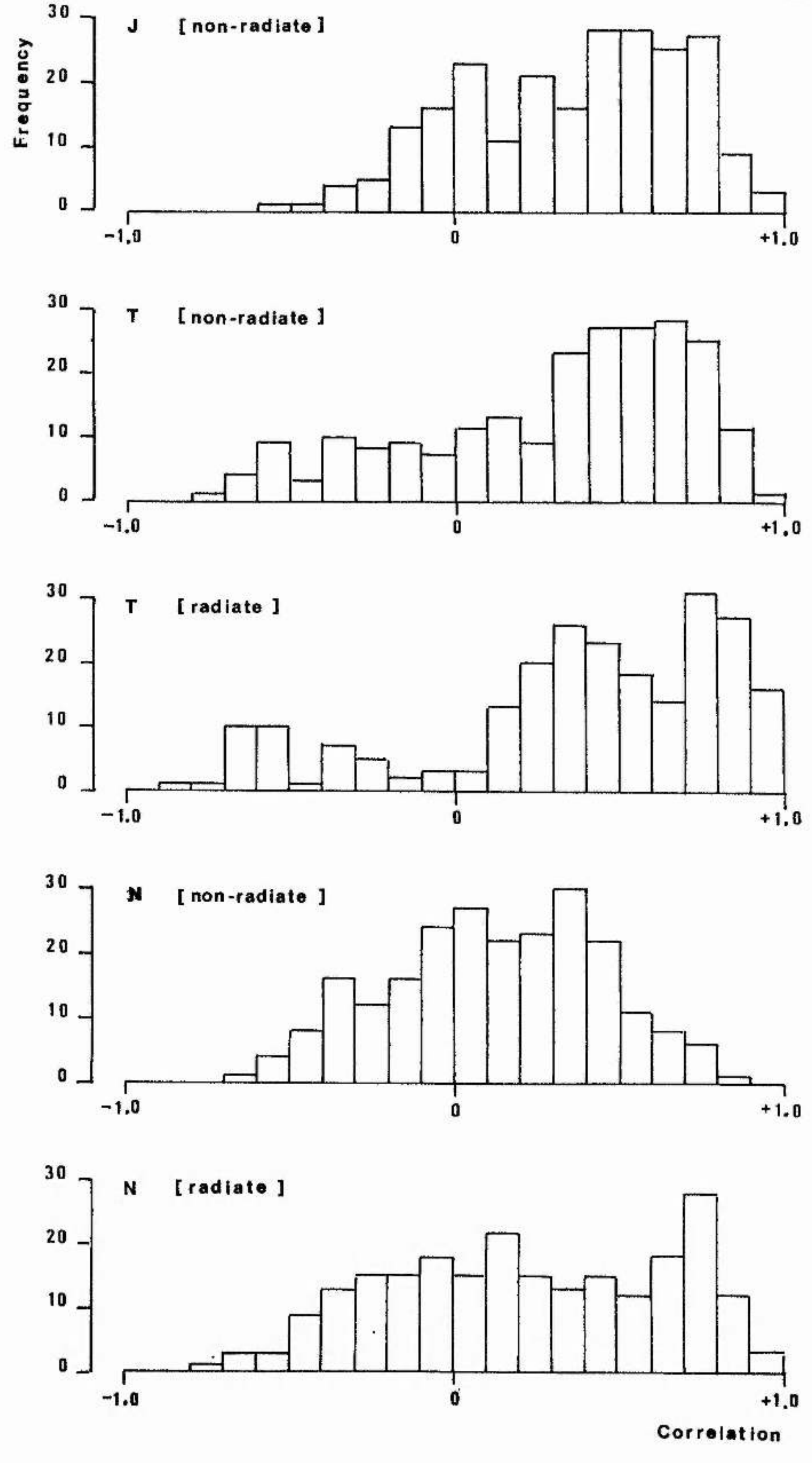


FIGURE 9.7.6 Histograms of the product-moment correlation coefficients of the 22 midleaf characters of non-radiate S. vulgaris from populations J, T and N, and radiate S. vulgaris from populations T and N.

groups are shown in Figure 9.7.7. It can be seen that the the non-radiate plants of the monomorphich population J, and both the radiate and non-radiate plants of population T, have distributions which are skewed in the positive direction. The distributions of the non-radiate and the radiate plants from population N, however, show a general shift towards the centre of the histogram, and show little skewness.

These results, therefore, suggest that inter-varietal hybridization is occurring, at least in some populations, between S. vulgaris var. vulgaris and S. vulgaris var. hibernicus.

9.8 Conclusion.

The results of both the discriminant function analyses of inter-population variation in non-radiate S. vulgaris, radiate S. vulgaris and S. squalidus and of the principal component analysis of the leaf characters of radiate and non-radiate S. vulgaris show that the geographic variation in both radiate and non-radiate S. vulgaris is associated with the relative geographic distributions of these morphs. In non-radiate S. vulgaris the primary division of the populations was on the basis of the presence or absence of radiate S. vulgaris. The secondary division was on the basis of longitude.

This secondary differentiation in non-radiate S. vulgaris was paralleled by the primary differentiation of the eastern and western populations in non-radiate S.

vulgaris. This separation of the eastern and the western populations of both radiate and non-radiate *S. vulgaris* may be due to environmental effects, or it may be due to the relative frequency of the radiate morph. Radiate *S. vulgaris* occurred much more frequently in the Edinburgh than in the Glasgow populations. The results of the principal component analysis of the leaf data, and the histograms of the character correlations suggest that inter-varietal hybridization is occuring in the eastern population N, but not in the western population T.

The results of the analysis of geographic variation, however, provided no evidence of current introgression of *S. squalidus* into *S. vulgaris* var. *vulgaris*. Although F_2 *S. vulgaris* x *S. squalidus* hybrids were obtained from F_1 hybrids found in the populations studied, these F_2 hybrids, as discussed in the previous section, appeared to be the result of backcrossing to *S. squalidus* rather than *S. vulgaris*.

10. DISCUSSION.

The purpose of this project was to re-examine the potential for introgression in the British Senecio polyploid complex, and in particular to study the possible introgression of the introduced Mediterranean diploid S. squalidus into the native tetraploid species, S. vulgaris and S. viscosus.

The potential for hybridization and introgression between the British Senecio species was assessed using three approaches. Controlled pollinations were made to determine the interfertility of the species, and to synthesize interspecific hybrids. Multivariate morphometric analyses of the interspecific hybrids and the parental species were used to determine the relative phenetic similarity of the hybrids to their parents. Thirdly, morphometric variation between natural populations of S. vulgaris var. vulgaris, S. vulgaris var. hibernicus, and S. squalidus was analysed to determine if the variation was related to geographical distribution.

The results of the crossing program are interesting in that , in addition to the triploid S. vulgaris x S. squalidus and S. viscosus x S. squalidus (S. x subnebrodensis) hybrids, a tetraploid S. vulgaris var. vulgaris X S. squalidus F_1 hybrid was obtained, as the result of the fusion of a non-reduced S. squalidus gamete with an haploid S. vulgaris var. vulgaris gamete. Secondly, although all attempts to backcross the F_1 triploid S. vulgaris x S. squalidus and S. x *subnebrodensis* hybrids to the tetraploid parental species, *S. vulgaris* and *S. viscosus*, failed, a tetraploid B_1 hybrid was obtained when the F_1 *S. vulgaris* var. *denticulatus* x *S. squalidus* hybrid was backcrossed with *S. squalidus*. This tetraploid B_1 hybrid must be presumed to have arisen by the functioning of an unreduced triploid gamete.

This backcross is an example of a ´triploid bridge´ whereby triploids serve as a mechanism to permit gene flow from the diploid to the tetraploid level. This mechanism has been shown to operate in hybrids between diploid and tetraploid races of *Dactylis glomerata* by Zohary & Nur (1959) who found that naturally occuring triploids of Dactylis produced large numbers of unreduced gametes, which gave fertile progeny when pollinated with diploid plants, and sterile pentaploid progeny when pollinated with tetraploid plants. It is this latter method, the formation of pentaploid and sub-pentaploid progeny of the F_1 triploid *S. vulgaris* x *S. squalidus* when backcrossed to *S. vulgaris*, which is suggested to have given rise to the radiate *S. vulgaris* var. hibernicus (Ingram, 1978). Similarly, it has been suggested that the formation of sub-pentaploid later generation *S.* x *subnebrodensis* hybrids may permit introgression into *S. viscosus* (Crisp & Jones, 1978).

However, both of these methods involve two stages, whereas the tetraploid *S. vulgaris* var. *vulgaris* x *S. squalidus* F_1 hybrid synthesized in this study acheived self-fertility and full interfertility with *S. vulgaris* in a single step. Jackson, Rowe & Hawkes (1978) in studying crosses between diploid and tetraploid potatoes (Solanum stenotomum ssp. stenotomum, and ssp. gomiocalyx, S. phureja, and S. tuberosum ssp. andigena) found that, although the potential for gene flow through triploid bridges existed, the progeny of triploid x tetraploid crosses being near tetraploids, and the progeny of triploid x diploid crosses being near-diploids, the direct transfer of genes from the diploid to the tetraploid by the formation of tetraploid F_1 hybrids from diploid x tetraploid crosses occurred much more frequently.

Non-reduction of gametes has been recorded as occurring commonly in Datura (Satina & Blakeslee, 1935), Trillium (Stern, 1946), Zea mays (Rhoades & Dempsey, 1966), Solanum phureja (Holgand, 1970; Lam, 1974), Solanum chacoense (Lam, 1974), Calamagrostis (Tateoka, 1977), Camilla (Ackerman & Kondo, 1980). Non-reduction is particularly common in orchid species (Teoh, 1980, 1984) and interspecific and intergeneric orchid hybrids (Tanaka & Kamemoto, 1960, 1961; Kamemoto & Tara, 1969; Arends, 1970).

Diploid x tetraploid interspecific crosses giving tetraploid F_1 hybrids have also been reported in Sorghum (Pritchard, 1965), Veronica (Raitanen, 1967), Prunus (Olden & Nybom, 1968), and the Medicago sativa-falcata complex (Stanford, Clement & Bingham, 1972).

There is some evidence that tetraploid S. vulgaris x S. squalidus hybrids may be formed in natural populations. Crisp (1972) found a single plant which was intermediate in morphology between _S. vulgaris_ and _S. squalidus_. This plant, although its chromosome number was not ascertained, gave autogamous progeny with 2n=38 to 2n=40, the majority having 2n=40. The descriptions of these progeny closely match those of the tetraploid F_2 _S. vulgaris_ var. _vulgaris_ x _S. squalidus_ hybrids synthesized in this project. In particular, some of the segregant leaf shapes (Crisp, 1972, Figure 13, p114) are very similar to those shown in Figure 8.2 in this thesis.

The mean ray floret length of the F_1 tetraploid hybrid synthesized in this study was 10.39mm, whereas the plant found by Crisp (1972) had a mean ray floret length of only 6.7mm. This is nearer the length of the triploid _S. vulgaris_ var. _vulgaris_ x _S. squalidus_ F_1 hybrids (5.23mm) which were obtained from the same cross as the tetraploid F^1 hybrid. The mean ray floret lengths of the F_2 hybrids in this study, the majority of which (26 out of 28) had mean lengths between 6.3mm and 12.3mm, were generally greater than those obtained by Crisp (1972), who found that 59 out of 63 plants had mean ray floret lengths between 1.5mm and 9.5mm.

The results of the second stage of this study, the morphometric analyses of the interspecific hybrids and their parental species, show that the relative morphological intermediacy of the hybrids is dependent on both the size of the parental species genome, i.e., n=10 or n=20, and on the number of genomes present.

In both the discriminant function analysis and the principal component analysis the diploid F_1 hybrids resulting from diploid x diploid crosses, i.e., *S. vernalis* x *S. squalidus*, and from tetraploid x tetraploid crosses, i.e., *S. vulgaris* var. *vulgaris* x autotetraploid *S. squalidus*, or backcrosses, i.e., F_1 (*S. vulgaris* var. *vulgaris* x *S. squalidus*) x *S. vulgaris* var. *vulgaris*, were all approximately equidistant from both parental species when plotted against the first two discriminant functions and the first two principal component axes.

The triploid F_1 hybrids obtained from tetraploid x diploid crosses, i.e., *S. vulgaris* var. *vulgaris* x *S. squalidus*, *S. vulgaris* var. *denticulatus* x *S. squalidus*, and *S.* x *subnebrodensis*, were all morphologically closer to the tetraploid parent than to the diploid *S. squalidus*.

In both the discriminant function analysis and the principal component analysis, the hexaploid *S. cambrensis*, which is believed to be an allopolyploid derived from *S. vulgaris* and *S. squalidus* (Rosser, 1955; Weir & Ingram, 1980), was found to be approximately equidistant from *S. vulgaris* and *S. squalidus*. In the cluster analyses, both the UPGMA and the ESS phenograms show *S. cambrensis* clustering with *S. squalidus* before fusing with *S. vulgaris*. That is, the results obtained in this study do not agree with the general observation that hexaploids are phenetically more similar to tetraploids than to diploids (Sneath & Sokal, 1973; Togan, Aydem, & Kence, 1983).

On the basis of these results it would appear that, if the radiate form of *S. vulgaris* arose as the result of introgression of *S. squalidus* into the non-radiate form of *S. vulgaris*, then the initial hybridization may have been at the tetraploid rather than the triploid level. Although the tetraploid F_1 hybrid was morphologicaly much closer to S. squalidus than to S. vulgaris var. vulgaris, the backcross hybrids were more similar to radiate S. vulgaris than the triploid F_1 S. vulgaris var. vulgaris x S. squalidus hybrid. That is, the results suggest that only a few generations of backcrossing and/or selfing of the tetraploid F_1 hybrid would be necessary to give rise to the radiate form of S. vulgaris.

Triploid S. vulgaris x S. squalidus hybrids have been recorded with reasonable regularity from natural populations (Stace, 1977; Brettel & Leslie, 1978; Valentine, 1979; Ingram, Weir, & Abbott, 1980; Marshall & Abbott, 1980), and a further three were found during this study. However, there are no confirmed records of any F_2 S. vulgaris x S. squalidus hybrids from natural populations, other than the single plant found by Crisp (1972), except for the three progeny obtained from two of the triploids found in natural populations during this study.

These three F_2 hybrids were found to have chromosome numbers of 2n=20, 2n=21, and 2n=27. These chromosome numbers, together with their correlated morphological variation in the direction of S. squalidus, suggest that these F_2 hybrids are backcross progeny of the triploid S. vulgaris var. vulgaris x S. squalidus with S. squalidus. In both the discriminant function analysis and the UPGMA cluster analysis the 2n=20 plant was grouped with S. squalidus, and the 2n=21 and 2n=27 plants were grouped with the S. vulgaris var. vulgaris x S. squalidus hybrids. In the principal component analysis and the ESS cluster analysis all three plants were grouped with the S. vulgaris var. vulgaris x S. squalidus hybrids.

Therefore, although the radiate form of S. vulgaris may have originated by introgression of S. squalidus into the non-radiate form of S. vulgaris, there is no evidence of continuing introgression ocurring in natural populations. The evidence presented in this thesis suggests that such introgression as occurs is of S. vulgaris into S. squalidus. That is, that introgression is in the opposite direction, from the tetraploid to the diploid species.

Similar evidence of introgression of the tetraploid into the diploid was found in natural populations of S. viscosus and S. squalidus. The triploid hybrid S. x subnebrodensis occurs regularly where the parental species are found together. It was found in six out of 11 mixed populations in this study. However, other than a single partially fertile triploid S. x subnebrodensis found by Crisp (1972), ther are no record of F_2 hybrids from natural populations. Two slightly fertile S. x subnebrodensis plants were found during this study. One, which was found at Methil Docks in Fife (population M in section 9), produced a single F_2 hybrid with a chromosome number of 2n=28. The other, which was found in Edinburgh (population N in section 9), produced three F_2 progeny with chromosome numbers of 2n=20.

In the discriminant function, principal components, UPGMA cluster, and ESS cluster analyses, the three 2n=20 F_2 hybrids were grouped with S. squalidus, and the 2n=28 F_2 hybrid was grouped with the S. vulgaris var. vulgaris x S. squalidus hybrids. The viscid glandular indumentum which is characteristic of S. viscosus and S. x subnebrodensis, was absent from all four F_2 hybrids.

The aneuploid chromosome numbers of the F_2 hybrids of both S. vulgaris var. vulgaris x S. squalidus and S. x subnebrodensis, and their phenetic similarity to S. squalidus, indicate that introgression of the tetraploid species of S. vulgaris and S. viscosus into the diploid S. squalidus is associated with the selective elimination of the S. vulgaris and S. viscosus genomes.

The preferential elimination of the parental genome in interspecific hybrids has been recorded by a number of authors. Stephens (1950) found that there was a significant elimination of the pollen donor genome in backcrosses of Gossypium hirsutum x G.barbadense to both parental species. Mangelsdorf (1958) found that there was rapid loss of the maize genome when Zea x Tripsacum hybrids were backcrossed to maize. Rick (1963) found that the Lycopersicon chilense was eliminated when L. esculentum x L. chilense hybrids were backcrossed to L. esculentum.

Vardi (1974) found that when hybrids of Triticum durum x Aegilops longissima and T. durum x A. speltoides were backcrossed to Aegilops, the F_3 progeny were all diploid or near-diploid. Kashu & Kao (1970) found that hybridization of Hordeum bulbosum and H. vulgare gave haploid H. vulgare progeny. Similarly Barclay (1975) found that crossing Triticum aestivum var. Chinese Spring with both diploid and tetraploid Hordeum vulgare produced haploid T. aestivum progeny.

Stalker, Harlan & DeWet (1977) analysed 33 morphological characters in aneuploid maize lines recovered from backcrossing Zea mays x Tripsacum dactyloides to maize, and found that a number of Tripsacum traits were detected in the 2n=20 progeny (20 maize chromosomes only) as well as in the 2n=22 progeny (20 maize + 2 Tripsacum chromosomes). That is, there was evidence of genetic transfer from the Tripsacum to the maize genome.

In this study the diploid S. vulgaris var. vulgaris x S. squalidus F_2 and the three S x subnebrodensis F_2s, however, were morphologically indistinguishable from S. squalidus. Grant (1967, 1981) has argued that linkage between genes determining morphology and genes determining physiological adaptation and viability, which he terms M-V linkage, will favour the selection of hybrids resembling one parental species.

Alternatively, the selective elimination of the tetraploid genomes in the F_2 S. vulgaris x S. squalidus and S. x subnebrodensis hybrids, may be related to spatial ordering of the chromosomes within the cell. Bennett (1982) found that in Secale africanum, S. cereale, and Hordeum vulgare cv. Tuleen 346, the spatial ordering of the chromosomes was non-random when examined by serial section electon microscopy. Not only were the haploid genomes spatially separate within the cell, but the order of the chromosomes within each haploid genome could be predicted. Therefore, if the genomes in an interspecific hybrid are spatially separate within the cell, this may explain the selective elimination of the S. vulgaris and S. viscosus n=20 genomes when the triploid hybrids are backcrossed to S. squalidus. However, it must be noted that there is as let no evidence that this occurs at meiosis.

In the third part of this study, the analysis of geographic variation in non-radiate S. vulgaris, radiate S. vulgaris, and s. squalidus,it was found that both radiate and non-radiate S. vulgaris exhibited geographic population differentiation. In S. squalidus, however, the inter-population variation was not correlated with geographical location.

In non-radiate S. vulgaris the primary component of population differentiation, as represented by the mean discriminant function scores on the first discriminant function, was directly correlated with the presence of radiate S. vulgaris in the population. The monomorphic populations had negative first discriminant function scores, the polymorphphic populations had positive first discriminant function scores. The second component of population differentation in non-radiate S. vulgaris, as represented by the mean discriminant function scores on the second discriminant function, was correlated with longitude. The populations in the eastern part of central Scotland had positive second discriminant function scores, and the populations in the western part had negative second discriminant function scores.

In radiate S. vulgaris the primary component of population differentiation, as represented by the mean first discriminant function scores, was also correlated with longitude. The populations in the eastern part of central Scotland had negative first discriminant function scores, and the populations in the west, the Glasgow populations, had positive first discriminant function scores. The second component of population differentiation in radiate S. vulgaris, as represented by the mean discriminant function scores on the second discriminant function, was correlated with the distribution of radiate S. vulgaris. The four populations which comprised the northern limit of the distribution of radiate S. vulgaris had positive second discriminant function scores, whereas the three more southern populations, in which the radiate allele was more frequent, had negative second discriminant function scores.

These results show that the two factors which affect the variation in natural populations of both radiate and non-radiate S. vulgaris are the presense of the radiate allele, and the longitude. It is extremely unlikely that these patterns of geographic variation are the result of random environmental effects, in that care was taken to include samples from both derelict and cultivated sites, and to randomize the order in which the sites were sampled in order to eliminate seasonal effects. Additionally, the variation in S. squalidus, which was found to be the most variable species in this study, was not correlated with the variation in S. vulgaris.

The results of the separate discriminant function analyses of radiate and non-radiate S. vulgaris using the full character set were paralleled by the results of the principal component analysis of the leaf character sub-set of radiate and non-radiate S. vulgaris. The first principal component was largely a size component, and was correlated with leaf length. The second and third principal components separated the leaves into four groups,

1. Non-radiate plants from populations A to D.
2. Non-radiate plants from populations E to L.
3. Non-radiate plants from populations M to U.
4. Radiate plants from populations M to U.

Only two of these four groups showed any overlap when plotted against the first two principal component axes, the non-radiate and the radiate plants from the polymorphic populations M to U. That is, the non-radiate plants from the polymorphic populations are phenetically closer to the radiate plants with respect to leaf shape.

When the character correlations of the 22 leaf characters in the population which showed the greatest degree of overlap between the radiate and non-radiate leaf shapes (population N) were compared with the character correlations in a polymorphic population which showed little overlap between the morphs (population T), and the character correlations in a momomorphic population

(population J), it was found that that the increased scatter of the radiate and non-radiate plants was associated with a decrease in the overall character correlation.

A similar increase in the scatter of OTUs against the principal component axes associated with a decrease in the character correlations was found in the analysis of leaf shape in the synthesized F_2 tetraploid S. vulgaris var. vulgaris x S. squalidus hybrids. Therefore, this may be considered as evidence for hybridization between radiate and non-radiate S. vulgaris.

However, in that segregants have been found, i.e. non-radiate plants with leaf shapes that ordinate with the radiate leaves, then the leaf shape traits associated with the radiate allele cannot be pleiotropic effects of that allele. Leaf shape in radiate S. vulgaris is therefore a polygentic character which is linked to the ray floret character. Therefore, in that these results show that the radiate allele is part of a linked polygenetic complex, thy are further evidence of an introgressant origin for S. vulgaris var. hibernicus.

11. CONCLUSION.

The results presented in this thesis suggest that although S. vulgaris var. hibernicus may have originated as a result of introgression of S. squalidus into S. vulgaris var. vulgaris, there is no evidence of current introgression in natural populations. However, there is evidence of introgression of S. viscosus and S. vulgaris into S. squalidus. That is, the results presented in this thesis suggest that introgression is proceeding in the opposite direction, from the tetraploids into the diploid.

Additionally, the identification of recombinant leaf shape segregants of radiate and non-radiate S. vulgaris, suggests that radiate S. vulgaris is introgressing into non-radiate S. vulgaris in the polymorphic populations.

Therefore on the basis of these results, two of the three species which were considered to be parental species, S. squalidus, S. vulgaris var. vulgaris, and S. viscosus, would appear to be introgressant forms. This, therefore raises a number questions.

The major question is the extent to which gene transfer into S. squalidus has ocurred. S. squalidus was found to be highly variable morphologically, although the British population is supposed to have derived from a single introduction. This variability may be due to introgression, or to the outcrossing breeding system in S. squalidus, or there may have been repeated introductions. S. vernalis, for example would appear to be introduced reasonbly frequently, two sites at which it occurred were found during this study.

The question of the extent of gene transfer into *S. squalidus* is complicated by the aneuploid chromosome numbers of the F_2 hybrids. The selective elimination of the tetraploid *S. vulgaris* and *S. squalidus* genomes, and the absence of detectable *S. vulgaris* and *S. viscosus* characters, may lead to a considerable underestimation of the ammount of hybridization and introgression which actually occurs.

However, the efficiency of numerical methods in detecting hybridization and introgression is demostrated by the results of this thesis. Although the F_2 *S. vulgaris* x *S. squalidus* and *S.* x *subnebrodensis* which had chromosome numbers of 2n=20 were not distiguishable from *S. squalidus*, the hybrids in which the elimination of the tetraploid genomes was not complete, the F_2 hybrids with 2n=21 to 2n=28, were clustered with the synthesized interspecific hybrids.

The results reported in this thesis show the usefulness of multivariate morphometric methods in analysisng geographic variation. Richards (1975) states that, apart from the ray floret character, radiate and non-radiate *S. vulgaris* are "otherwise indistinguishable", and Stace (1977) states that "apart from the presence of ray florets, radiate *S. vulgaris* seems identical with non-radiate *S. vulgaris*." However, using numerical methods, it was possible not only to distinguish between radiate and non-radiate *S. vulgaris*, but also to distinguish between non-radiate *S. vulgaris* form monomorphic populations and non-radiate *S. vulgaris* from polymorphic populations.

In conclusion, the aim of this study was to investigate the potential for introgression in the British Senecio polyploid complex. It has been demonstrated that introgression has occurred, and is occurring, within this complex, and has considerable taxonomic importance within this group.

12. BIBLIOGRAPHY.

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13. APPENDIX 1.

OTU numbers, line numbers, locations of the original populations, generation numbers, and the number of replicates of the pure species lines, interspecific hybrid lines, and the interspecific hybrids obtained from natural populations.

LINE No.	SPECIES		ORIGINAL POPULATION	GENERATION	No. of REPLICATES	OTU NUMBERS
011	*S. vulgaris* var.	*vulgaris*	Leeds	2nd selfed	15	01101-01115
012	"	"	Ainsdale, Lancs.	open pollinated, wild collection	9	01201-01209
013	"	"	Edinburgh	1st selfed	14	01301-01314
014	"	"	Ainsdale, Lancs.	open pollinated, wild collection	20	01401-01420
015	"	"	St. Andrews, Fife	1st selfed	22	01501-01522
016	"	"	Puffin Is.	2nd selfed	10	01601-01610
017	"	"	Bot. Gdns., St. Andrews	1st selfed	3	01701-01703
021	*S. vulgaris* var.	*hibernicus*	Leeds	2nd selfed	15	02101-02115
022	"	"	Ainsdale, Lancs.	open pollinated, wild collection	3	02201-02203
023	"	"	Ffrith, Wales	open pollinated, wild collection	20	02301-02303
031	*S. vulgaris*	*denticulatus*	Guernsey, Channel Is.	1st selfed	17	03101-03117
032	"	"	Ainsdale, Lancs.	1st selfed	26	03201-03226
041	*S. squalidus*		Bot. Gdns., Oxford	open pollinated, wild collection	2	04101-04102
042	"		Trentino, Italy	Bot. Gdns. Accession	10	04201-04220
043	"		Edinburgh (Salamander St.)	open pollinated, wild collection	16	04301-04316
044	"		Anker Bridge, Staffs.	F_1 NRSQAL A10115 × A9115	20	04401-04420
045	"		Bot. Gdns., St. Andrews	F_1 NRSQAL × MSQAL	17	04501-04517
046	"		Ainsdale, Lancs.	F_1 LT4SQAL LT4/10 × 474/8	34	04601-04634

LINE No.	SPECIES	ORIGINAL POPULATION	GENERATION	No. of REPLICATES	OTU NUMBERS
051	*S. cambrensis*	Ffrith, Wales	1st selfed	19	05191-05119
052	*S. cambrensis*	Edinburgh (Quilts)	1st selfed	17	05201-05217
061	*S. viscosus*	Fifeness, Fife	open pollinated, wild collection	10	06101-06110
071	*S. sylvaticus*	Tentsmuir, Fife	open pollinated, wild collection	10	07101-07110
081	*S. vernalis*	Broughtyferry, Dundee	open pollinated, wild collection	3	08101-08103
411	autotetraploid *S. squalidus*	Aberystwyth, Wales	C_1 (Houston, 1983)	7	44101-44107

Line No.		Generation	2n=	Parent Plant No.	No. of replicates	OTU No.
111	*S. vulgaris* var. *vulgaris* × *S. squalidus*	F_1	30	013/7 × 046/21	1	11101
131	*S. vulgaris* var. *denticulatus* × *S. squalidus*	F_1	30	032/B11 × 044/A8.7	1	13101
141	131 (F_1) × *S. squalidus*	B_1	40	131 × 044/7	1	14101
151	*S. vulgaris* var. *vulgaris* × *S. squalidus*	F_1	40	013/7 × 046/21	1	15101
161	151 (F_1) selfed	F_1	40	151 selfed	28	16101–16128
171	151 (F_1) × *S. vulgaris* var. *vulgaris*	B_1	40	151 × 013/3	20	17101–17120
172	151 (F_1) × *S. vulgaris* var. *vulgaris*	B_1	40	151 × 013/2	10	17201–17210
181	*S. vulgaris* var. *vulgaris* × C_1 *S. squalidus*	F_1	40	17/1 × 411/1	18	18101–18118
211	*S. viscosus* × *S. squalidus*	F_1	30	061/B6 × 044/C7.3	13	21101–21113
212	*S. squalidus* × *S. viscosus*	F_1	30	045/6 × 061/B7	5	21201–21205
331	*S. vernalis* × *S. squalidus*	F_1	20	081/1 × 046/17	3	33101–33103

Line No.		Generation	2n=	Original Population	Popn.	OTU No.
121	*S. vulgaris* var. *vulgaris* × *S. squalidus*	F_2	20	Edinburgh, Granton Docks	0	12101
122	*S. vulgaris* var. *vulgaris* × *S. squalidus*	F_2	21	Liverpool	-	12201
122	*S. vulgaris* var. *vulgaris* × *S. squalidus*	F_2	27	Liverpool	-	12202
221	*S. x subnebrodensis*	F_2	28	Methil Docks	M	21101
222	*S. x subnebrodensis*	F_2	20	Edinburgh, Salamander St.	N	21201
222	*S. x subnebrodensis*	F_2	20	Edinburgh, Salamander St.	N	21202
222	*S. x subnebrodensis*	F_2	20	Edinburgh, Salamander St.	N	21203

14. APPENDIX 2.

Means, standard deviations, variances of the 63 continuous characters C01 to C63, and number of replicates of the 38 species and interspecific hybrid lines grown under standard conditions. The origin and parentage of the lines are given in Appendix 1.

Character C01 Days to Flowering

Line	Mean	Std Dev	Variance	n
011	43.7333	5.2436	27.4952	15
012	39.7778	4.5216	20.4444	9
013	45.7857	6.0533	36.6429	14
014	44.5500	8.5562	73.2079	20
015	47.5000	3.1585	9.9762	22
016	57.0000	1.1547	1.3333	10
017	60.0000	1.4142	2.0000	2
021	45.7333	6.7238	45.2095	15
022	51.6667	5.1316	26.3333	3
023	43.3500	1.2680	1.6079	20
031	91.4118	8.3071	69.0074	17
032	28.8077	24.2965	590.3215	26
041	61.0000	7.0711	50.0000	2
042	62.5000	9.3555	87.5263	20
043	68.6250	12.7587	162.7833	16
044	66.5500	5.2262	27.3132	20
045	67.4118	16.9339	286.7574	17
046	79.0294	14.0637	197.7870	34
051	54.3684	4.6333	21.4678	19
052	55.7647	2.6346	6.9412	17
061	83.3000	6.2725	39.3444	10
071	79.5000	2.2236	4.9444	10
081	53.3333	6.6583	44.3333	3
111	39.0000	0.0000	0.0000	1
121	75.0000	0.0000	0.0000	1
122	80.0000	1.4142	2.0000	2
131	84.0000	0.0000	0.0000	1
141	63.0000	0.0000	0.0000	1
151	47.0000	0.0000	0.0000	1
161	63.2143	4.2978	18.4709	28
171	53.2333	4.2482	18.0471	30
181	68.8889	2.2199	4.9281	18
211	63.7692	9.3019	86.5256	13
212	56.2000	6.6858	44.7000	5
221	70.0000	0.0000	0.0000	1
222	84.0000	6.9282	48.0000	3
331	79.6667	18.2300	332.3333	3
441	97.8571	4.0178	16.1429	7

Character C02 Plant Height

Line	Mean	Std Dev	variance	n
011	16.5333	50.5765	2557.9810	15
012	73.4444	41.1525	1693.5278	9
013	96.2143	14.2028	201.7198	14
014	24.5000	31.3411	982.2632	20
015	19.7727	32.7166	1070.3745	22
016	44.0000	30.2875	917.3333	10
017	58.0000	1.4142	2.0000	2
021	16.1333	47.0104	2209.9810	15
022	24.3333	45.6216	2081.3333	3
023	36.2500	24.8064	615.3553	20
031	70.5294	111.0603	12334.3897	17
032	77.3846	162.7155	26476.3262	26
041	84.0000	21.2132	450.0000	2
042	17.7000	58.2861	3397.2737	20
043	25.2500	119.6888	14325.4000	16
044	52.7000	105.4729	11124.5368	20
045	87.5882	50.6397	2564.3824	17
046	68.8529	35.3579	18321.7656	34
051	96.2632	129.2723	16711.3158	19
052	08.4706	72.9624	5323.5147	17
061	63.0000	94.4093	8913.1111	10
071	65.5000	62.3275	3884.7222	10
081	25.0000	38.1576	1456.0000	3
111	22.0000	0.0000	0.0000	1
121	84.0000	0.0000	0.0000	1
122	41.5000	58.6899	3444.5000	2
131	58.0000	0.0000	0.0000	1
141	39.0000	0.0000	0.0000	1
151	54.0000	0.0000	0.0000	1
161	13.2857	79.2076	6273.8413	28
171	26.7333	108.9106	11861.5126	30
181	81.2778	74.2221	5508.9183	18
211	60.2308	83.0202	6892.3590	13
212	29.2000	44.5724	1986.7000	5
221	11.0000	0.0000	0.0000	1
222	02.0000	25.6320	657.0000	3
331	90.3333	38.2143	1460.3333	3
441	73.2857	84.5433	7147.5714	7

Character C03 Inflorescence Length

Line	Mean	Std Dev	Variance	n
011	20.5333	3.8148	14.5524	15
012	20.3333	3.6742	13.5000	9
013	15.2857	2.7576	7.6044	14
014	21.6500	6.1411	37.7132	20
015	18.4545	3.5150	12.3550	22
016	25.4000	2.5906	6.7111	10
017	17.5000	2.1213	4.5000	2
021	17.1333	4.3731	19.1238	15
022	23.3333	5.1316	26.3333	3
023	20.0000	3.6850	13.5789	20
031	18.0588	4.5479	20.6838	17
032	16.5385	1.7025	2.8985	26
041	50.5000	17.6777	312.5000	2
042	52.9500	21.6077	466.8921	20
043	48.8750	11.1527	124.3833	16
044	51.6000	11.0520	122.1474	20
045	57.9412	18.4779	341.4338	17
046	46.9412	10.5656	111.6328	34
051	34.5789	5.8435	34.1462	19
052	28.7647	3.3825	11.4412	17
061	33.6000	5.7388	32.9333	10
071	35.4000	4.1150	16.9333	10
081	25.6667	7.0946	50.3333	3
111	22.0000	0.0000	0.0000	1
121	16.0000	0.0000	0.0000	1
122	21.0000	1.4142	2.0000	2
131	23.0000	0.0000	0.0000	1
141	20.0000	0.0000	0.0000	1
151	24.0000	0.0000	0.0000	1
161	27.9286	6.3183	39.9206	28
171	25.6333	6.0770	36.9299	30
181	18.3889	1.1950	1.4281	18
211	33.3846	10.5715	111.7564	13
212	36.0000	5.1478	26.5000	5
221	16.0000	0.0000	0.0000	1
222	28.3333	3.2146	10.3333	3
331	32.6667	3.2146	10.3333	3
441	34.1429	7.5372	56.8095	7

Character C04 Number Of Internodes

Line	Mean	Std Dev	Variance	n
011	18.4000	1.2984	1.6857	15
012	13.0000	2.5981	6.7500	9
013	16.2143	2.6364	6.9505	14
014	14.9000	3.8784	15.0421	20
015	18.0909	2.2234	4.9437	22
016	28.8000	1.3166	1.7333	10
017	25.5000	0.7071	0.5000	2
021	17.2667	1.8310	3.3524	15
022	21.3333	2.5166	6.3333	3
023	16.2500	1.0699	1.1447	20
031	30.9412	3.0510	9.3088	17
032	37.5000	1.9442	3.7800	26
041	15.0000	1.4142	2.0000	2
042	17.7000	3.2783	10.7474	20
043	19.2500	3.3367	11.1333	16
044	19.3500	2.2308	4.9763	20
044	20.9412	4.3799	19.1838	17
046	26.0000	4.0751	16.6061	34
051	18.0000	3.8006	14.4444	19
052	19.4118	2.0328	4.1324	17
061	29.0000	1.5635	2.4444	10
071	43.4000	2.4129	5.8222	10
081	51.0000	6.5574	43.0000	3
111	14.0000	0.0000	0.0000	1
121	22.0000	0.0000	0.0000	1
122	28.5000	4.9497	24.5000	2
131	30.0000	0.0000	0.0000	1
141	27.0000	0.0000	0.0000	1
151	16.0000	0.0000	0.0000	1
161	21.3214	2.8552	8.1521	28
171	19.7667	3.5300	12.4609	30
181	24.5556	1.1991	1.4379	18
211	19.0000	3.2660	10.6667	13
212	16.2000	1.7889	3.2000	5
221	28.0000	0.0000	0.0000	1
222	25.0000	1.0000	1.0000	3
331	27.6667	2.5166	6.3333	3
441	30.1429	0.8997	0.8095	7

Character C05 Basal Stem Diameter

Line	Mean	Std Dev	variance	n
011	4.9200	1.2031	1.4474	15
012	4.2111	1.0179	1.0361	9
013	4.1357	0.4700	0.2209	14
014	4.5350	0.6651	0.4424	20
015	4.6091	0.7171	0.5142	22
016	6.0300	0.5376	0.2890	10
017	4.9000	0.1414	0.0200	2
021	5.2067	1.3382	1.7907	15
022	4.4000	0.7810	0.6100	3
023	5.3200	0.3302	0.1091	20
031	5.3706	0.9019	0.8135	17
032	5.9500	1.9445	3.7810	26
041	4.5000	0.0000	0.0000	2
042	5.1300	0.5904	0.3485	20
043	6.8500	1.3246	1.7547	16
044	5.7350	0.8499	0.7224	20
045	5.2294	0.9571	0.9160	17
046	6.2941	0.9782	0.9569	34
051	7.1474	0.6586	0.4337	19
052	7.7529	0.7993	0.6389	17
061	6.1600	0.9336	0.8716	10
071	7.8500	1.2250	1.5006	10
081	9.2333	0.4163	0.1733	3
111	5.2000	0.0000	0.0000	1
121	6.0000	0.0000	0.0000	1
122	4.8000	0.8485	0.7200	2
131	7.4000	0.0000	0.0000	1
141	4.6000	0.0000	0.0000	1
151	4.2000	0.0000	0.0000	1
161	6.1643	0.8547	0.7305	28
171	6.3433	1.1319	1.2812	30
181	5.6111	0.4702	0.2210	18
211	5.0000	0.6770	0.4583	13
212	4.8800	0.6573	0.4320	5
221	5.2000	0.0000	0.0000	1
222	7.5333	0.9504	0.9033	3
331	7.1667	2.2811	5.2033	3
441	7.6857	0.5178	0.2681	7

Character C06 Number Of Leaves

Line	Mean	Std Dev	Variance	n
011	56.2000	15.9383	254.0286	15
012	31.8889	12.1804	148.3611	9
013	40.4286	12.8405	164.8791	14
014	47.3500	15.7088	246.7658	20
015	52.9545	5.8836	34.6169	22
016	01.0000	14.0475	197.3333	10
017	03.5000	3.5355	12.5000	2
021	52.6000	16.3698	267.9714	15
022	58.6667	20.9841	440.3333	3
023	51.0500	5.8172	33.8395	20
031	09.2941	20.0118	400.4706	17
032	14.8462	56.9334	3241.4154	26
041	33.0000	15.5563	242.0000	2
042	58.4500	17.9370	321.7342	20
043	94.1875	40.6107	1649.2292	16
044	86.1500	48.3717	2339.8184	20
045	53.0000	12.8841	166.0000	17
046	09.9118	32.5226	1057.7193	34
051	77.6842	17.7922	316.5614	19
052	79.8235	18.2045	331.4044	17
061	47.0000	17.8885	320.0000	10
071	98.0000	21.0555	443.3333	10
081	60.0000	4.0000	16.0000	3
111	25.0000	0.0000	0.0000	1
121	74.0000	0.0000	0.0000	1
122	22.5000	28.9914	840.5000	2
131	13.0000	0.0000	0.0000	1
141	68.0000	0.0000	0.0000	1
151	26.0000	0.0000	0.0000	1
161	84.7143	21.5954	466.3598	28
171	88.1667	21.1938	449.1782	30
181	67.5000	10.1822	103.6765	18
211	28.7692	4.6216	21.3590	13
212	35.6000	5.0299	25.3000	5
221	85.0000	0.0000	0.0000	1
222	84.0000	16.0935	259.0000	3
31	45.3333	6.1101	37.3333	3
441	68.1429	5.2418	27.4762	7

Charater C07 Proportion Of Laterals with Capitula

Line	Mean	Std Dev	Variance	n
011	0.9353	0.0839	0.0070	15
012	0.8811	0.2454	0.0602	9
013	0.8943	0.0933	0.0087	14
014	0.9095	0.0755	0.0057	20
015	0.9018	0.0476	0.0023	22
016	0.8410	0.0338	0.0011	10
017	0.9200	0.0000	0.0000	2
021	0.8980	0.0868	0.0075	15
022	0.4167	0.1563	0.0244	3
023	0.9375	0.0064	0.0000	20
031	0.2712	0.0877	0.0077	17
032	0.1642	0.0648	0.0042	26
041	0.1400	0.0141	0.0002	2
042	0.3045	0.0924	0.0085	20
043	0.5738	0.3663	0.1342	16
044	0.5075	0.3744	0.1402	20
045	0.1959	0.1026	0.0105	17
046	0.3644	0.2780	0.0773	34
051	0.8842	0.1043	0.0109	19
052	0.8918	0.0944	0.0089	17
061	0.2800	0.0340	0.0012	10
071	0.2180	0.0509	0.0026	10
081	0.1100	0.0400	0.0016	3
111	0.4300	0.0000	0.0000	1
121	0.5000	0.0000	0.0000	1
122	0.4300	0.1273	0.0162	2
131	0.2400	0.0000	0.0000	1
141	0.4400	0.0000	0.0000	1
151	0.2700	0.0000	0.0000	1
161	0.6564	0.2123	0.0451	28
171	0.9170	0.0884	0.0078	30
181	0.3367	0.1187	0.0141	18
211	0.2623	0.0893	0.0080	13
212	0.3500	0.1002	0.0101	5
211	0.4300	0.0000	0.0000	1
212	0.3767	0.0252	0.0006	3
331	0.0733	0.0058	0.0000	3
441	0.1643	0.0251	0.0006	7

Character C08 Longest Leaf Length

Line	Mean	Std Dev	Variance	n
011	39.6000	25.6927	660.1143	15
012	17.0000	20.9523	439.0000	9
013	36.8571	18.8184	354.1319	14
014	40.8500	16.0141	256.4500	20
015	46.6364	13.6715	186.9091	22
016	77.2000	9.1869	84.4000	10
017	71.0000	9.8995	98.0000	2
021	28.2000	22.0946	488.1714	15
022	25.0000	15.7162	247.0000	3
023	48.6500	11.7306	137.6079	20
031	55.8824	45.1856	2041.7353	17
032	51.2308	36.0913	1302.5846	26
041	96.5000	28.9914	840.5000	2
042	39.7500	31.3350	981.8816	20
043	55.7500	35.6305	1269.5333	16
044	42.9000	29.2699	856.7263	20
045	17.9412	12.5721	158.0588	17
046	83.8824	28.9092	835.7433	34
051	84.0000	13.4330	180.4444	19
052	02.8235	16.5236	273.0294	17
061	96.0000	19.6299	385.3333	10
071	20.6000	8.7458	76.4889	10
081	49.6667	20.1329	405.3333	3
111	50.0000	0.0000	0.0000	1
121	64.0000	0.0000	0.0000	1
122	78.5000	0.7071	0.5000	2
131	93.0000	0.0000	0.0000	1
141	88.0000	0.0000	0.0000	1
151	56.0000	0.0000	0.0000	1
161	90.9286	29.3004	858.5132	28
171	83.0333	22.1258	489.5506	30
181	10.1111	15.1187	228.5752	18
211	16.3077	15.3915	236.8974	13
212	15.2000	12.7750	163.2000	5
221	90.0000	0.0000	0.0000	1
222	65.0000	10.8167	117.0000	3
331	43.6667	13.4288	180.3333	3
441	68.2857	8.8264	77.9048	7

Character C09 Midleaf Length

Line	Mean	Std Dev	Variance	n
011	10.6667	23.0734	532.3810	15
012	92.8889	29.4637	868.1111	9
013	22.2143	22.5258	507.4121	14
014	27.1500	12.9869	168.6605	20
015	23.2273	17.9866	323.5173	22
016	33.3000	16.9840	288.4556	10
027	35.5000	10.6066	112.5000	2
021	98.4000	18.2866	334.4000	15
022	67.3333	12.0554	145.3333	3
023	27.8000	7.1422	51.0105	20
031	78.7059	29.2506	855.5956	17
032	68.3462	21.3034	453.8354	26
041	63.5000	4.9497	24.5000	2
042	97.7000	48.1982	2323.0632	20
043	04.9375	37.8655	1433.7958	16
044	89.4000	32.2105	1037.5158	20
045	61.2941	10.2394	104.8456	17
046	32.8529	31.3979	985.8262	34
051	51.1053	15.1140	228.4327	19
052	51.0000	13.0480	170.2500	17
061	48.5000	8.0035	64.0556	10
071	67.9000	8.2253	67.6556	10
081	40.0000	2.0000	4.0000	3
111	03.0000	0.0000	0.0000	1
121	42.0000	0.0000	0.0000	1
122	29.0000	24.0416	578.0000	2
131	90.0000	0.0000	0.0000	1
141	61.0000	0.0000	0.0000	1
151	58.0000	0.0000	0.0000	1
161	52.7500	28.0972	789.4537	28
171	41.6000	24.2225	586.7310	30
181	39.4444	15.7899	249.3203	18
211	53.4615	6.6410	44.1026	13
212	63.8000	3.0332	9.2000	5
221	26.0000	0.0000	0.0000	1
222	40.6667	19.6554	386.3333	3
331	54.3333	12.5033	156.3333	3
441	01.0000	10.9545	120.0000	7

Character C101 MLF Total Leaf Max Width

mean	std dev	variance		n
50.6667	10.9196	119.2381	(	15)
36.2222	9.8079	96.1944	(	9)
48.6429	7.8506	61.6319	(	14)
63.1500	10.0487	100.9763	(	20)
65.6818	6.3199	39.9416	(	22)
66.8000	5.9963	35.9556	(	10)
63.0000	1.4142	2.0000	(	2)
52.8000	10.8904	118.6000	(	15)
22.0000	5.0000	25.0000	(	3)
62.1500	4.4518	19.8184	(	20)
26.8824	9.3400	87.2353	(	17)
20.7692	9.7090	94.2646	(	26)
50.5000	2.1213	4.5000	(	2)
47.9500	28.5868	817.2079	(	20)
60.1875	27.7013	767.3625	(	16)
63.3000	29.9211	895.2737	(	20)
28.0000	6.5860	43.3750	(	17)
82.6176	24.1937	585.3342	(	34)
07.4737	18.8779	356.3743	(	19)
80.1176	11.3020	127.7353	(	17)
27.9000	7.0467	49.6556	(	10)
28.9000	2.2336	4.9889	(	10)
11.3333	0.5774	0.3333	(	3)
55.0000	0.0000	0.0000	(	1)
05.0000	0.0000	0.0000	(	1)
75.5000	3.5355	12.5000	(	2)
33.0000	0.0000	0.0000	(	1)
86.0000	0.0000	0.0000	(	1)
39.0000	0.0000	0.0000	(	1)
99.7500	15.4335	238.1944	(	28)
93.0333	16.0290	256.9299	(	30)
77.3889	9.3754	87.8987	(	18)
27.7692	4.1464	17.1923	(	13)
37.2000	5.8907	34.7000	(	5)
89.0000	0.0000	0.0000	(	1)
19.6667	19.2180	369.3333	(	3)
24.6667	2.3094	5.3333	(	3)
76.8571	6.9864	48.8095	(	7)

Character C121 MLF Mean Base to Max Width Length

mean	std dev	variance		n
65.7000	12.6643	160.3857	(	15)
56.6111	17.7918	316.5486	(	9)
79.8571	21.3896	457.5165	(	14)
70.3250	9.9516	99.0336	(	20)
68.4318	10.3352	106.8166	(	22)
64.3000	11.7170	137.2889	(	10)
85.2500	8.8388	78.1250	(	2)
55.1667	11.6568	135.8810	(	15)
46.6667	11.5578	133.5833	(	3)
76.8250	9.0543	81.9809	(	20)
56.9706	25.4402	647.2022	(	17)
45.9808	8.5913	73.8096	(	26)
34.0000	9.1924	84.5000	(	2)
50.0750	19.1293	365.9283	(	20)
54.6563	17.7527	315.1573	(	16)
49.8750	16.4580	270.8651	(	20)
36.4706	9.2542	85.6397	(	17)
72.8382	18.5973	345.8594	(	34)
84.7105	16.4269	269.8421	(	19)
90.3824	10.4620	109.4540	(	17)
30.5500	4.7167	22.2472	(	10)
35.0500	8.7320	76.2472	(	10)
23.0000	2.2913	5.2500	(	3)
56.0000	0.0000	0.0000	(	1)
70.0000	0.0000	0.0000	(	1)
73.0000	2.1213	4.5000	(	2)
57.5000	0.0000	0.0000	(	1)
13.0000	0.0000	0.0000	(	1)
35.0000	0.0000	0.0000	(	1)
82.6786	14.8712	221.1521	(	28)
77.1500	15.8033	249.7440	(	30)
88.7222	13.7501	189.0654	(	18)
32.1538	5.5692	31.0160	(	13)
39.4000	3.3053	10.9250	(	5)
87.0000	0.0000	0.0000	(	1)
62.5000	9.8489	97.0000	(	3)
34.0000	13.4815	181.7500	(	3)
65.6429	6.1489	37.8095	(	7)

Character C14 MLF Auricle Length

Line	Mean	Std Dev	Variance	n
011	19.4667	7.0495	49.6952	15
012	11.8889	4.5947	21.1111	9
013	14.3571	3.0786	9.4780	14
014	23.0000	4.1422	17.1579	20
015	20.5455	5.5612	30.9264	22
016	17.9000	4.1218	16.9889	10
017	22.5000	2.1213	4.5000	2
021	15.6667	5.3005	28.0952	15
022	6.6667	4.5092	20.3333	3
023	19.2000	2.8764	8.2737	20
031	4.5294	2.2945	5.2647	17
032	5.0769	1.6474	2.7138	26
041	14.5000	3.5355	12.5000	2
042	18.7000	11.6759	136.3263	20
043	15.9375	10.4401	108.9958	16
044	12.3000	6.7831	46.0105	20
045	10.8824	6.5754	43.2353	17
046	8.0294	4.9328	24.3324	34
051	26.2105	7.7930	60.7310	19
052	19.8235	2.8556	8.1544	17
061	5.3000	4.0838	16.6778	10
071	9.1000	1.1972	1.4333	10
081	4.6667	0.5774	0.3333	3
111	10.0000	0.0000	0.0000	1
121	30.0000	0.0000	0.0000	1
122	14.0000	14.1421	200.0000	2
131	4.0000	0.0000	0.0000	1
141	5.0000	0.0000	0.0000	1
151	10.0000	0.0000	0.0000	1
161	20.5357	5.1746	26.7765	28
171	25.0000	8.5177	72.5517	30
181	14.8333	4.8779	23.7941	18
211	10.8462	2.4443	5.9744	13
212	11.6000	3.7815	14.3000	5
221	12.0000	0.0000	0.0000	1
222	16.6667	3.5119	12.3333	3
331	6.3333	0.5774	0.3333	3
441	8.5714	5.0615	25.6190	7

Character C15 MLF Auricle Width

Line	mean	std dev	variance	n
011	24.4000	10.4047	108.2571	15
012	12.2222	4.4659	19.9444	9
013	17.4286	3.4354	11.8022	14
014	30.0500	6.3202	39.9447	20
015	28.1818	8.8513	78.3463	22
016	27.8000	3.9665	15.7333	10
017	27.0000	4.2426	18.0000	2
021	22.4667	9.2957	86.4095	15
022	9.3333	4.5092	20.3333	3
023	29.7000	4.0013	16.0105	20
031	6.7647	1.4803	2.1912	17
032	8.3462	1.5733	2.4754	26
041	26.5000	10.6066	112.5000	2
042	23.4000	13.0924	171.4105	20
043	21.3750	14.1321	199.7167	16
044	15.5000	12.2796	150.7895	20
045	9.8824	5.3137	28.2353	17
046	9.7059	5.3966	29.1230	34
051	35.6316	7.5514	57.0234	19
052	27.4118	4.1088	16.8824	17
061	6.5000	4.8819	23.8333	10
071	9.7000	2.6687	7.1222	10
081	6.3333	0.5774	0.3333	3
111	18.0000	0.0000	0.0000	1
121	27.0000	0.0000	0.0000	1
122	6.0000	0.0000	0.0000	1
131	6.0000	0.0000	0.0000	1
141	8.0000	0.0000	0.0000	1
151	13.0000	0.0000	0.0000	1
161	27.3214	9.9891	99.7817	28
171	39.4333	12.9500	167.7023	30
181	14.8889	4.8736	23.7516	18
211	12.0769	2.7827	7.7436	13
212	13.4000	3.9115	15.3000	5
221	13.0000	0.0000	0.0000	1
222	19.3333	5.5076	30.3333	3
331	8.0000	1.0000	1.0000	3
441	9.2857	6.1023	37.2381	7

Character C16 MLF Number of Lobes

	mean	std dev	variance	n
011	9.2000	0.4140	0.1714	15
012	10.7778	1.3017	1.6944	9
013	10.1429	0.7703	0.5934	14
014	11.1500	0.9333	0.8711	20
015	9.0909	0.4264	0.1818	22
016	9.7000	0.8233	0.6778	10
017	10.0000	0.0000	0.0000	2
021	9.0667	0.8837	0.7810	15
022	10.0000	1.0000	1.0000	3
023	8.9000	0.6407	0.4105	20
031	9.1176	0.8575	0.7353	17
032	7.9231	0.6884	0.4738	26
041	7.5000	0.7071	0.5000	2
042	8.9500	1.4681	2.1553	20
043	8.6875	0.9465	0.8958	16
044	7.5000	0.9459	0.8947	20
045	7.6471	1.1695	1.3676	17
046	7.2941	1.0597	1.1230	34
051	8.3684	0.8307	0.6901	19
052	9.1176	0.6966	0.4853	17
061	12.4000	0.8433	0.7111	10
071	13.0000	0.6667	0.4444	10
081	9.0000	0.0000	0.0000	3
111	11.0000	0.0000	0.0000	1
121	7.0000	0.0000	0.0000	1
122	8.0000	1.4142	2.0000	2
131	8.0000	0.0000	0.0000	1
141	7.0000	0.0000	0.0000	1
151	10.0000	0.0000	0.0000	1
161	9.5000	1.5986	2.5556	28
171	9.0333	1.2726	1.6195	30
181	10.3889	1.1448	1.3105	18
211	9.1538	1.2142	1.4744	13
212	9.2000	1.3038	1.7000	5
221	7.0000	0.0000	0.0000	1
222	7.3333	0.5774	0.3333	3
331	9.0000	0.0000	0.0000	3
441	7.0000	1.1547	1.3333	7

Character C17 MLF Apical Lobe Length

Line	mean	std dev	variance	n
011	28.5333	5.4885	30.1238	15
012	18.7778	5.3333	28.4444	9
013	31.2857	2.9724	8.8352	14
014	28.2500	4.7002	22.0921	20
015	31.5455	3.9608	15.6883	22
016	35.7000	4.0565	16.4556	10
017	40.0000	2.8284	8.0000	2
021	27.9333	7.3627	54.2095	15
022	14.3333	2.0817	4.3333	3
023	35.7500	4.5175	20.4079	20
031	16.2941	10.2272	104.5956	17
032	18.1154	6.3582	40.4262	26
041	25.5000	2.1213	4.5000	2
042	33.0000	15.7346	247.5789	20
043	42.1875	14.1149	199.2292	16
044	37.5000	13.6517	186.3684	20
045	24.9412	6.7682	45.8088	17
046	49.4118	11.6648	136.0677	34
051	50.2105	5.5235	30.5088	19
052	45.9412	6.8508	46.9338	17
061	10.0000	2.5820	6.6667	10
071	8.8000	2.2010	4.8444	10
081	6.6667	0.5774	0.3333	3
111	26.0000	0.0000	0.0000	1
121	59.0000	0.0000	0.0000	1
122	41.5000	2.1213	4.5000	2
131	29.0000	0.0000	0.0000	1
141	48.0000	0.0000	0.0000	1
151	24.0000	0.0000	0.0000	1
161	48.9643	9.2676	85.8876	28
171	47.6333	9.7856	95.7575	30
181	46.9444	5.4930	30.1732	18
211	17.5385	5.1578	26.6026	13
212	22.0000	5.3852	29.0000	5
221	57.0000	0.0000	0.0000	1
222	58.6667	8.5049	72.3333	3
331	16.0000	3.6056	13.0000	3
441	47.1429	6.2297	38.8095	7

Character C18 MLF Apical Lobe Width

	mean	std dev	varaince	n
011	12.3333	2.5261	6.3810	15
012	9.4444	2.7889	7.7778	9
013	20.7143	3.5826	12.8352	14
014	15.5500	2.6848	7.2079	20
015	16.4091	3.1722	10.0628	22
016	19.7000	2.3594	5.5667	10
017	18.0000	0.0000	0.0000	2
021	17.7333	7.7962	60.7810	15
022	8.3333	2.5166	6.3333	3
023	16.7500	2.8261	7.9868	20
031	8.5294	5.3981	29.1397	17
032	32.6154	2.8011	7.8462	26
041	804100	0.0000	0.0000	2
042	17.9000	9.0023	81.0421	20
043	17.3750	6.3757	40.6500	16
044	14.2000	6.6142	43.7474	20
045	9.4706	2.0651	4.2647	17
046	18.5000	5.8426	34.1364	34
051	23.5263	5.7770	33.3743	19
052	22.9412	2.9890	8.9338	17
061	6.3000	2.0575	4.2333	10
071	6.3000	2.1628	4.6778	10
081	6.6667	1.1547	1.3333	3
111	9.0000	0.0000	0.0000	1
122	14.5000	0.7071	0.5000	2
131	13.0000	0.0000	0.0000	1
141	15.0000	0.0000	0.0000	1
151	12.0000	0.0000	0.0000	1
161	24.4286	7.8807	62.1058	28
171	25.9667	6.9256	47.9644	30
181	27.3889	4.2996	18.4869	18
211	9.3077	2.1750	4.7308	13
212	9.4000	2.1909	4.8000	5
221	44.0000	0.0000	0.0000	1
222	34.6667	4.1633	17.3333	3
331	8.0000	1.7321	3.0000	3
441	27.8571	3.8048	14.4762	7

Character C19 MLF Longest Lobe Length

	mean	std dev	variance	n
011	31.1333	5.5274	30.5524	15
012	22.4444	5.4109	29.2778	9
013	33.6429	5.5554	30.8626	14
014	36.9500	4.7404	22.4711	20
015	40.0909	3.3652	11.3247	22
016	40.3000	3.5292	12.4556	10
017	40.5000	2.1213	4.5000	2
021	31.9333	5.6879	32.3524	15
022	19.0000	5.5678	31.0000	3
023	36.8000	7.1936	51.7474	20
031	17.9412	7.7980	60.8088	17
032	16.3846	6.0997	37.2062	26
041	31.5000	2.1213	4.5000	2
042	32.8500	18.5820	345.2921	20
043	41.1875	13.4076	179.7625	16
044	40.5500	13.5277	182.9974	20
045	26.1765	7.5931	57.6544	17
046	55.6765	14.0167	196.4679	34
051	69.1053	13.2577	175.7661	19
052	52.6471	4.9742	24.7426	17
061	18.4000	3.9215	15.3778	10
071	19.6000	2.4129	5.8222	10
081	6.3333	0.5774	0.3333	3
111	37.0000	0.0000	0.0000	1
121	56.0000	0.0000	0.0000	1
122	56.0000	7.0711	50.0000	2
131	25.0000	0.0000	0.0000	1
141	58.0000	0.0000	0.0000	1
151	26.0000	0.0000	0.0000	1
161	61.2143	9.3030	86.5450	28
171	56.1000	8.7231	76.0931	30
181	54.0556	6.0534	36.6438	18
211	20.6923	3.0655	9.3974	13
212	26.0000	2.2361	5.0000	5
221	61.0000	0.0000	0.0000	1
222	78.0000	5.5678	31.0000	3
331	18.3333	4.6188	21.3333	3
441	52.5714	7.6126	57.9524	7

Character C20 MLF Mid-Lobe Length

Line	mean	std dev	variance	n
011	30.3333	5.0238	25.2381	15
012	22.0000	5.3852	29.0000	9
013	33.3571	5.5416	30.7088	14
014	35.1500	5.2443	27.5026	20
015	38.3182	3.7719	14.2273	22
016	38.6000	4.3767	19.1556	10
017	39.5000	0.7071	0.5000	2
021	30.4667	5.3301	28.4095	15
022	18.3333	5.0332	25.3333	3
023	37.2500	3.6974	13.6711	20
031	16.3529	6.4415	41.4926	17
032	14.8462	5.9106	34.9354	26
041	30.5000	3.5355	12.5000	2
042	29.8000	17.0220	289.7474	20
043	37.0000	10.9179	119.2000	16
044	38.9500	12.5550	157.6289	20
045	24.0000	6.9101	47.7500	17
046	50.6176	11.7731	138.6070	34
051	61.6842	10.3444	107.0058	19
052	50.4706	5.1492	26.5147	17
061	17.9000	4.0125	16.1000	10
071	18.6000	2.5473	6.4889	10
081	6.0000	0.0000	0.0000	3
111	37.0000	0.0000	0.0000	1
121	56.0000	0.0000	0.0000	1
122	53.0000	2.8284	8.0000	2
131	25.0000	0.0000	0.0000	1
141	58.0000	0.0000	0.0000	1
151	26.0000	0.0000	0.0000	1
161	57.1071	8.5346	72.8399	28
171	53.3667	8.4465	71.3437	30
181	51.0000	5.1564	26.5882	18
211	19.7692	2.4884	6.1923	13
212	24.4000	3.0496	9.3000	5
221	50.0000	0.0000	0.0000	1
222	72.3333	7.6376	58.3333	3
331	16.6667	4.5092	20.3333	3
441	49.4286	8.6189	74.2857	7

Character C21 MLF Mid-Lobe Max Width A

Line	mean	std dev	variance	n
011	5.9333	0.8837	0.7810	15
012	5.2222	1.4814	2.1944	9
013	8.0000	1.4676	2.1538	14
014	6.6000	1.3917	1.9368	20
015	7.2273	1.1098	1.2316	22
016	7.6000	1.1738	1.3778	10
017	8.0000	1.4142	2.0000	2
021	7.9333	2.2824	5.2095	15
022	3.3333	1.5275	2.3333	3
023	8.1000	1.0712	1.1474	20
031	3.9412	1.4349	2.0588	17
032	3.0000	1.1314	1.2800	26
041	4.0000	0.0000	0.0000	2
042	6.1500	4.2708	18.2395	20
043	4.5625	2.0320	4.1292	16
044	3.7500	1.6504	2.7237	20
045	2.5294	0.6243	0.3897	17
046	4.7059	1.9467	3.7897	34
051	9.9474	2.8572	8.1637	19
052	9.1765	1.7405	3.0294	17
061	4.1000	0.7379	0.5444	10
071	3.7000	0.8233	0.6778	10
081	2.3333	0.5774	0.3333	3
111	5.0000	0.0000	0.0000	1
121	4.0000	0.0000	0.0000	1
122	7.0000	1.4142	2.0000	2
131	5.0000	0.0000	0.0000	1
141	10.0000	0.0000	0.0000	1
151	4.0000	0.0000	0.0000	1
161	7.9286	2.2596	5.1058	28
171	9.4667	2.2242	4.9471	30
181	10.3333	1.0290	1.0588	18
211	3.9231	0.7596	0.5769	13
212	4.4000	0.5477	0.3000	5
221	10.0000	0.0000	0.0000	1
222	9.3333	1.1547	1.3333	3
333	2.6667	1.1547	1.3333	3
441	9.1429	1.3452	1.8095	7

Character C22 MLF Mid-Lobe Midrib to Max Width A

line	mean	std dev	variance	n
011	16.4000	2.4727	6.1143	15
012	14.5556	4.2164	17.7778	9
013	20.4286	4.0328	16.2637	14
014	18.9000	4.5061	20.3053	20
015	20.0909	4.0345	16.2771	22
016	18.5000	2.8771	8.2778	10
017	23.0000	2.8284	8.0000	2
021	16.4667	3.5227	12.4095	15
022	18.0000	7.9373	63.0000	3
023	17.8000	2.3306	5.4316	20
031	9.8824	5.5213	30.4853	17
032	10.5385	4.0322	16.2585	26
041	20.0000	4.2426	18.0000	2
042	21.9500	13.3986	179.5237	20
043	21.7500	6.7872	46.0667	16
044	23.3000	7.4770	55.9053	20
045	15.9412	4.2935	18.4338	17
046	31.0588	9.4064	88.4813	34
051	41.4737	10.0353	100.7076	19
052	32.3529	5.5783	31.1176	17
061	14.5000	3.6893	13.6111	10
071	12.3000	2.0575	4.2333	10
081	6.0000	0.0000	0.0000	3
111	25.0000	0.0000	0.0000	1
121	30.0000	0.0000	0.0000	1
122	33.5000	14.8492	220.5000	2
131	21.0000	0.0000	0.0000	1
141	48.0000	0.0000	0.0000	1
151	13.0000	0.0000	0.0000	1
161	33.1429	9.4779	89.8307	28
171	28.2000	12.9466	167.6138	30
181	32.6111	6.3351	40.1340	18
211	15.4615	2.4364	5.9359	13
212	19.6000	3.4351	11.8000	5
221	42.0000	0.0000	0.0000	1
222	37.0000	2.6458	7.0000	3
331	12.6667	4.6188	21.3333	3
441	35.4286	7.1846	51.6190	7

Character C23 MLF Mid-Lobe Max Width B

Line	mean	std dev	variance	n
011	6.5333	1.3020	1.6952	15
012	4.7778	1.6415	2.6944	9
013	8.7143	1.9779	3.9121	14
014	8.4000	1.6026	2.5684	20
015	9.5455	1.0568	1.1169	22
016	8.5000	1.4337	2.0556	10
017	10.0000	1.4142	2.0000	2
021	8.7333	2.3442	5.4952	15
022	4.0000	1.0000	1.0000	3
023	7.3000	1.1743	1.3789	20
031	4.4706	2.1540	4.6397	17
032	3.1538	1.2229	1.4954	26
041	7.5000	0.7071	0.5000	2
042	10.2000	6.7011	44.9053	20
043	7.2500	3.7859	14.3333	16
044	5.6000	2.8359	8.0421	20
045	3.5294	0.7998	0.6397	17
046	9.2059	3.6662	13.4412	34
051	17.9474	6.6789	44.6082	19
052	10.7059	1.5315	2.3456	17
061	5.4000	1.5055	2.2667	10
071	5.8000	1.1353	1.2889	10
081	3.0000	0.0000	0.0000	3
111	7.0000	0.0000	0.0000	1
121	12.5000	0.7071	0.5000	2
122	5.0000	0.0000	0.0000	1
131	19.0000	0.0000	0.0000	1
141	6.0000	0.0000	0.0000	1
151	12.5714	4.1671	17.3651	28
161	12.9667	3.0680	9.4126	30
171	14.3889	2.0041	4.0163	18
212	5.8000	0.8367	0.7000	5
221	21.0000	0.0000	0.0000	1
222	15.3333	0.5774	0.3333	3
331	3.3333	1.5275	2.3333	3
441	12.2857	2.2147	4.9048	7

Charaacter C24 MLF Mid-Lobe Midrib to Max Width B

Line	mean	std dev	variance	n
011	12.2000	4.4753	20.0286	(15)
012	14.6667	5.3852	29.0000	(9)
013	20.2857	6.9440	48.2198	(14)
014	14.0000	4.7903	22.9474	(20)
015	15.8636	5.3922	29.0758	(22)
016	17.0000	3.6515	13.3333	(10)
017	16.5000	2.1213	4.5000	(2)
021	17.4000	4.3061	18.5429	(15)
022	10.6667	3.5119	12.3333	(3)
023	17.9000	5.0669	25.6737	(20)
031	10.9412	4.1151	16.9338	(17)
032	10.6923	4.2967	18.4615	(26)
041	19.0000	8.4853	72.0000	(2)
042	17.1000	9.6894	93.8842	(20)
043	18.7500	7.0285	49.4000	(16)
044	19.9500	7.9570	63.3132	(20)
045	15.5882	5.0505	25.5074	(17)
046	26.2941	9.6688	93.4866	(34)
051	32.8947	11.5993	134.5439	(19)
052	27.0588	6.6846	44.6838	(17)
061	12.9000	3.4464	11.8778	(10)
071	6.8000	2.0440	4.1778	(10)
081	2.6667	1.5275	2.3333	(3)
111	27.0000	0.0000	0.0000	(1)
121	38.0000	0.0000	0.0000	(1)
122	27.5000	6.3640	40.5000	(2)
131	19.0000	0.0000	0.0000	(1)
141	28.0000	0.0000	0.0000	(1)
151	19.0000	0.0000	0.0000	(1)
161	32.6429	9.4132	88.6085	(28)
171	25.4333	7.7089	59.4264	(30)
181	28.5556	8.3611	69.9085	(18)
211	13.5385	1.8536	3.4359	(13)
212	19.0000	2.0000	4.0000	(5)
221	24.0000	0.0000	0.0000	(1)
222	42.3333	14.9778	224.3333	(3)
331	11.6667	3.0551	9.3333	(3)
441	33.7143	12.4862	155.9048	(7)

Character C25 MLF MID-LOBE APICAL WIDTH

mean	std dev	variance		n
4.5333	1.0601	1.1238	(	15)
4.1111	1.2693	1.6111	(	9)
6.6429	1.3927	1.9396	(	14)
6.6000	1.2732	1.6211	(	20)
7.0909	1.1916	1.4199	(	22)
5.6000	1.0750	1.1556	(	10)
7.5000	0.7071	0.5000	(	2)
3.3333	0.9759	0.9524	(	15)
2.6667	1.1547	1.3333	(	3)
4.7500	0.7864	0.6184	(	20)
3.0000	0.9354	0.8750	(	17)
2.3077	0.4707	0.2215	(	26)
4.0000	0.0000	0.0000	(	2)
5.1500	2.3458	5.5026	(	20)
5.3750	2.3058	5.3167	(	16)
4.3000	1.2183	1.4842	(	20)
3.1176	1.1114	1.2353	(	17)
4.9118	1.5446	2.3859	(	34)
9.1579	1.8638	3.4737	(	19)
8.6471	1.7299	2.9926	(	17)
4.0000	0.8165	0.6667	(	10)
3.2000	0.6325	0.4000	(	10)
2.3333	0.5774	0.3333	(	3)
4.0000	0.0000	0.0000	(	1)
9.0000	0.0000	0.0000	(	1)
5.5000	0.7071	0.5000	(	2)
4.0000	0.0000	0.0000	(	1)
8.0000	0.0000	0.0000	(	1)
3.0000	0.0000	0.0000	(	1)
6.1071	2.1489	4.6177	(	28)
7.1667	2.3354	5.4540	(	30)
9.6111	1.1448	1.3105	(	18)
4.0000	1.2247	1.5000	(	13)
5.6000	0.5477	0.3000	(	5)
9.0000	0.0000	0.0000	(	1)
8.3333	0.5774	0.3333	(	3)
2.6667	0.5774	0.3333	(	3)
5.7143	1.3801	1.9048	(	7)

Character C26 MLF Mid-Lobe Basal Width

mean	std dev	variance		n
13.0667	2.3745	5.6381	(	15)
12.0000	4.2720	18.2500	(	9)
15.5000	1.7431	3.0385	(	14)
14.4500	3.5759	12.7868	(	20)
15.5455	2.9877	8.9264	(	22)
13.3000	2.0575	4.2333	(	10)
12.0000	1.4142	2.0000	(	2)
13.0667	2.6040	6.7810	(	15)
8.0000	1.7321	3.0000	(	3)
15.1500	1.1821	1.3974	(	20)
6.8824	1.8669	3.4853	(	17)
7.5000	1.5811	2.5000	(	26)
3.0000	0.0000	0.0000	(	2)
8.2500	3.3067	10.9342	(	20)
9.0000	4.1150	16.9333	(	16)
6.5500	3.3321	11.1026	(	20)
5.0000	1.6956	2.8750	(	17)
7.2647	1.8309	3.3520	(	34)
13.0526	2.5270	6.3860	(	19)
20.4118	1.7698	3.1324	(	17)
3.5000	0.8498	0.7222	(	10)
4.3000	0.9487	0.9000	(	10)
6.0000	1.0000	1.0000	(	3)
11.0000	0.0000	0.0000	(	1)
7.0000	0.0000	0.0000	(	1)
9.0000	1.4142	2.0000	(	2)
11.0000	0.0000	0.0000	(	1)
13.0000	0.0000	0.0000	(	1)
4.0000	0.0000	0.0000	(	1)
9.0714	2.8665	8.2169	(	28)
12.2667	3.2156	10.3402	(	30)
10.3889	1.4608	2.1340	(	18)
3.5385	0.9674	0.9359	(	13)
5.4000	1.1402	1.3000	(	5)
14.0000	0.0000	0.0000	(	1)
7.6667	0.5774	0.3333	(	3)
5.0000	1.0000	1.0000	(	3)
5.4286	2.5071	6.2857	(	7)

Character C27 MLF Mid-Lobe Lamina Width

mean	std dev	variance	n
5.2000	1.0142	1.0286	(15)
4.2222	1.5635	2.4444	(9)
7.7143	1.5407	2.3736	(14)
7.0500	1.2763	1.6289	(20)
7.3182	1.2492	1.5606	(22)
7.5000	1.0801	1.1667	(10)
7.5000	0.7071	0.5000	(2)
4.2667	1.3870	1.9238	(15)
2.6667	0.5774	0.3333	(3)
5.0500	0.6048	0.3658	(20)
2.7059	0.9852	0.9706	(17)
2.9231	1.0168	1.0338	(26)
1.5000	0.7071	0.5000	(2)
3.8500	2.6611	7.0816	(20)
4.4375	3.1826	10.1292	(16)
2.8000	1.6416	2.6947	(20)
1.8235	0.8090	0.6544	(17)
4.0000	1.5374	2.3636	(34)
5.2632	1.9103	3.6491	(19)
10.1176	2.1179	4.4853	(17)
1.2000	0.4216	0.1778	(10)
1.6000	0.5164	0.2667	(10)
2.3333	0.5774	0.3333	(3)
4.0000	0.0000	0.0000	(1)
5.0000	0.0000	0.0000	(1)
6.0000	0.0000	0.0000	(2)
3.0000	0.0000	0.0000	(1)
8.0000	0.0000	0.0000	(1)
1.0000	0.0000	0.0000	(1)
5.3214	1.8867	3.5595	(28)
5.4667	1.5698	2.4644	(30)
5.7778	1.3086	1.7124	(18)
1.3846	0.5064	0.2564	(13)
2.0000	0.7071	0.5000	(5)
9.0000	0.0000	0.0000	(1)
3.3333	0.5774	0.3333	(3)
2.0000	0.0000	0.0000	(3)
2.4286	0.5345	0.2857	(7)

Character C28 MLF Intercostal Length A

mean	std dev	variance	n
19.1333	3.7007	13.6952	(15)
15.1111	6.0093	36.1111	(9)
20.3571	3.7336	13.9396	(14)
19.0000	4.3890	19.2632	(20)
21.6364	4.3155	18.6234	(22)
22.2000	3.1552	9.9556	(10)
23.0000	1.4142	2.0000	(2)
16.0000	3.6839	13.5714	(15)
8.3333	2.0817	4.3333	(3)
24.0500	2.7810	7.7342	(20)
12.0588	4.2201	17.8088	(17)
10.3846	2.8011	7.8462	(26)
28.5000	6.3640	40.5000	(2)
16.1000	9.9414	98.8316	(20)
14.5000	5.0990	26.0000	(16)
15.9500	5.2663	27.7342	(20)
11.2353	4.5625	20.8162	(17)
26.2353	13.3463	178.1248	(34)
25.6842	7.7032	59.3392	(19)
17.8235	3.3211	11.0294	(17)
8.4000	2.0656	4.2667	(10)
8.5000	1.6499	2.7222	(10)
6.6667	0.5774	0.3333	(3)
18.0000	0.0000	0.0000	(1)
27.0000	0.0000	0.0000	(1)
18.5000	6.3640	40.5000	(2)
15.0000	0.0000	0.0000	(1)
16.0000	0.0000	0.0000	(1)
10.0000	0.0000	0.0000	(1)
23.2143	6.1545	37.8783	(28)
23.4000	6.1229	37.4897	(30)
22.5000	3.7924	14.3824	(18)
9.5385	1.9839	3.9359	(13)
12.2000	1.7889	3.2000	(5)
17.0000	0.0000	0.0000	(1)
24.3333	9.2916	86.3333	(3)
9.6667	2.0817	4.3333	(3)
20.8571	10.5740	111.8095	(7)

Character C29 MLF Intercostal Length B

mean	std dev	variance	n
19.8000	3.7071	13.7429	(15)
16.6667	7.1764	51.5000	(9)
24.9286	5.5673	30.9945	(14)
21.7000	3.7006	13.6947	(20)
23.1364	3.8705	14.9805	(22)
26.9000	3.7550	14.1000	(10)
23.0000	5.6569	32.0000	(2)
17.6667	4.8648	23.6667	(15)
10.6667	3.5119	12.3333	(3)
25.2500	2.3368	5.4605	(20)
14.3529	5.7330	32.8676	(17)
12.8846	4.8689	23.7062	(26)
9.0000	4.2426	18.0000	(2)
15.7000	8.8562	78.4316	(20)
16.7500	7.5675	57.2667	(16)
12.9000	5.9551	35.4632	(20)
9.5294	3.4481	11.8897	(17)
20.9706	6.4125	41.1203	(34)
23.8947	4.0674	16.5439	(19)
16.1176	2.9556	8.7353	(17)
6.6000	1.4298	2.0444	(10)
11.5000	1.0801	1.1667	(10)
4.6667	2.5166	6.3333	(3)
17.0000	0.0000	0.0000	(1)
26.0000	0.0000	0.0000	(1)
20.5000	4.9497	24.5000	(2)
14.0000	0.0000	0.0000	(1)
19.0000	0.0000	0.0000	(1)
9.0000	0.0000	0.0000	(1)
20.1429	6.2699	39.3122	(28)
20.4333	4.2725	18.2540	(30)
17.2778	2.7398	7.5065	(18)
8.0000	2.0817	4.3333	(13)
10.4000	2.1909	4.8000	(5)
8.0000	0.0000	0.0000	(1)
18.0000	1.7321	3.0000	(3)
9.0000	1.0000	1.0000	(3)
10.8571	2.7946	7.8095	(7)

Character C30 MLF Apical Angle A

mean	std dev	variance		n
88.4000	12.2870	150.9714	(	15)
90.6667	19.7864	391.5000	(	9)
87.7857	11.0952	123.1044	(	14)
84.4000	12.9102	166.6737	(	20)
95.7727	9.4513	89.3268	(	22)
92.7000	6.6005	43.5667	(	10)
77.0000	7.0711	50.0000	(	2)
56.8000	11.2897	127.4571	(	15)
59.0000	9.8489	97.0000	(	3)
80.3500	7.2712	52.8711	(	20)
75.8824	17.8146	317.3603	(	17)
73.6923	11.4465	131.0215	(	26)
54.5000	20.5061	420.5000	(	2)
80.0000	18.8652	355.8947	(	20)
57.3125	10.8180	117.0292	(	16)
51.6500	13.7545	189.1868	(	20)
50.5294	15.6569	245.1397	(	17)
61.6176	13.9805	195.4554	(	34)
56.8421	12.4198	154.2515	(	19)
54.5882	6.4523	41.6324	(	17)
80.7000	7.7323	59.7889	(	10)
62.1000	10.3971	108.1000	(	10)
03.6667	4.1633	17.3333	(	3)
89.0000	0.0000	0.0000	(	1)
85.0000	0.0000	0.0000	(	1)
58.5000	23.3345	544.5000	(	2)
60.0000	0.0000	0.0000	(	1)
69.0000	0.0000	0.0000	(	1)
72.0000	0.0000	0.0000	(	1)
67.7500	17.9580	322.4907	(	28)
80.8333	12.8199	164.3506	(	30)
74.2222	8.2857	68.6536	(	18)
72.8462	9.6940	93.9744	(	13)
74.4000	11.6319	135.3000	(	5)
83.0000	0.0000	0.0000	(	1)
70.3333	10.0167	100.3333	(	3)
64.3333	7.7675	60.3333	(	3)
64.7143	19.8806	395.2381	(	7)

Character C31 MLF Apical Angle B

mean	std dev	variance		n
08.3333	7.7980	60.8095	(	15)
06.7778	8.4525	71.4444	(	9)
09.8571	6.8709	47.2088	(	14)
08.5000	9.0467	81.8421	(	20)
06.0909	9.7586	95.2294	(	22)
09.4000	7.6333	58.2667	(	10)
06.0000	2.8284	8.0000	(	2)
08.6000	8.8139	77.6857	(	15)
10.3333	11.5902	134.3333	(	3)
02.0000	4.0000	16.0000	(	20)
01.1765	16.7826	281.6544	(	17)
94.0385	7.7433	59.9585	(	26)
01.0000	1.4142	2.0000	(	2)
89.5000	9.2594	85.7368	(	20)
88.1875	10.1273	102.5625	(	16)
91.8500	16.0502	257.6079	(	20)
82.9412	17.9912	323.6838	(	17)
99.7941	9.6790	93.6836	(	34)
08.1053	8.2724	68.4327	(	19)
10.2353	6.4955	42.1912	(	17)
11.4000	9.1433	83.6000	(	10)
96.6000	8.5661	73.3778	(	10)
88.0000	5.0000	25.0000	(	3)
15.0000	0.0000	0.0000	(	1)
95.0000	0.0000	0.0000	(	1)
4.0000	11.3137	128.0000	(	2)
92.0000	0.0000	0.0000	(	1)
21.0000	0.0000	0.0000	(	1)
13.0000	0.0000	0.0000	(	1)
11.1429	11.4106	130.2011	(	28)
07.9333	11.3318	128.4092	(	30)
07.7778	5.4076	29.2418	(	18)
96.3846	11.4567	131.2564	(	13)
87.2000	8.1976	67.2000	(	5)
16.0000	0.0000	0.0000	(	1)
19.6667	29.8385	890.3333	(	3)
87.6667	2.5166	6.3333	(	3)
17.4286	9.4315	88.9524	(	7)

Character C32 MLF Basal Angle A

mean	std dev	variance		n
53.8000	6.0616	36.7429	(	15)
57.4444	16.6216	276.2778	(	9)
61.3571	11.7185	137.3242	(	14)
65.3000	12.1443	147.4842	(	20)
70.2273	14.5305	211.1364	(	22)
67.3000	14.3531	206.0111	(	10)
65.0000	14.1421	200.0000	(	2)
72.2667	8.7298	76.2095	(	15)
40.0000	28.1603	793.0000	(	3)
73.4500	7.6673	58.7868	(	20)
27.1765	6.7011	44.9044	(	17)
30.0769	7.7404	59.9138	(	26)
88.5000	16.2635	264.5000	(	2)
69.6000	20.0457	401.8316	(	20)
73.7500	19.6384	385.6667	(	16)
67.7000	18.6720	348.6421	(	20)
56.0000	12.4549	155.1250	(	17)
63.6765	16.1259	260.0437	(	34)
86.5789	14.8523	220.5906	(	19)
65.6471	13.5598	183.8676	(	17)
65.5000	8.7845	77.1667	(	10)
62.6000	6.3805	40.7111	(	10)
33.3333	1.5275	2.3333	(	3)
69.0000	0.0000	0.0000	(	1)
75.0000	0.0000	0.0000	(	1)
70.0000	9.8995	98.0000	(	2)
30.0000	0.0000	0.0000	(	1)
38.0000	0.0000	0.0000	(	1)
71.0000	0.0000	0.0000	(	1)
75.9286	12.3196	151.7725	(	28)
85.1667	14.2080	201.8678	(	30)
57.8333	9.6665	93.4412	(	18)
65.6923	9.0405	81.7308	(	13)
66.4000	11.9917	143.8000	(	5)
75.0000	0.0000	0.0000	(	1)
01.3333	19.3993	376.3333	(	3)
54.3333	14.0119	196.3333	(	3)
71.0000	10.2794	105.6667	(	7)

Character C33 MLF Basal Angle B

mean	std dev	variance		n
60.3333	18.5035	342.3810	(	15)
07.6667	37.5366	1409.0000	(	9)
03.5000	27.2305	741.5000	(	14)
13.8000	30.6982	942.3789	(	20)
82.9091	19.6151	384.7532	(	22)
73.2000	14.3898	207.0667	(	10)
11.5000	20.5061	420.5000	(	2)
17.6667	19.6856	387.5238	(	15)
51.0000	35.5949	1267.0000	(	3)
24.9500	12.0677	145.6289	(	20)
69.8235	30.2329	914.0294	(	17)
64.4615	10.0806	101.6185	(	26)
49.5000	6.3640	40.5000	(	2)
72.5000	41.9392	1758.8947	(	20)
08.8125	32.7826	1074.6958	(	16)
67.8500	31.0336	963.0816	(	20)
10.0000	45.6111	2080.3750	(	17)
80.5588	42.5941	1814.2540	(	34)
00.0000	24.5493	602.6667	(	19)
14.4706	20.6795	427.6397	(	17)
75.1000	11.2788	127.2111	(	10)
86.8000	10.8403	117.5111	(	10)
50.6667	2.5166	6.3333	(	3)
53.0000	0.0000	0.0000	(	1)
80.0000	0.0000	0.0000	(	1)
85.0000	5.6569	32.0000	(	2)
42.0000	0.0000	0.0000	(	1)
96.0000	0.0000	0.0000	(	1)
28.0000	0.0000	0.0000	(	1)
34.3571	36.9266	1363.5714	(	28)
90.5667	23.6959	561.4954	(	30)
50.2222	46.2786	2141.7124	(	18)
30.2308	28.9228	836.5256	(	13)
44.4000	11.8659	140.8000	(	5)
52.0000	0.0000	0.0000	(	1)
12.3333	13.0512	170.3333	(	3)
42.3333	0.5774	0.3333	(	3)
70.8571	37.8393	1431.8095	(	7)

Character C34 MLF Secondary Vein Angle

mean	std dev	variance		n
60.1333	4.5335	20.5524	(	15)
62.0000	9.6825	93.7500	(	9)
52.5714	8.1686	66.7253	(	14)
68.6500	5.9848	35.8184	(	20)
54.5909	6.3370	40.1580	(	22)
55.5000	9.7895	95.8333	(	10)
57.0000	4.2426	18.0000	(	2)
59.2000	7.4948	56.1714	(	15)
47.0000	7.8102	61.0000	(	3)
66.3500	5.0812	25.8184	(	20)
61.0588	8.9266	79.6838	(	17)
58.3077	5.9918	35.9015	(	26)
62.5000	16.2635	264.5000	(	2)
42.2000	9.4178	88.6947	(	20)
45.1250	8.2209	67.5833	(	16)
54.7000	13.0630	170.6421	(	20)
32.9412	10.8194	117.0588	(	17)
51.8824	11.4700	131.5615	(	34)
47.2105	12.5414	157.2865	(	19)
48.1176	9.2187	84.9853	(	17)
53.9000	8.3858	70.3222	(	10)
48.2000	7.9134	62.6222	(	10)
62.3333	2.0817	4.3333	(	3)
60.0000	0.0000	0.0000	(	1)
74.0000	0.0000	0.0000	(	1)
44.5000	2.1213	4.5000	(	2)
45.0000	0.0000	0.0000	(	1)
47.0000	0.0000	0.0000	(	1)
53.0000	0.0000	0.0000	(	1)
53.8571	13.3797	179.0159	(	28)
55.7333	9.7235	94.5471	(	30)
46.7778	8.3353	69.4771	(	18)
41.6923	4.3853	19.2308	(	13)
41.2000	3.8987	15.2000	(	5)
30.0000	0.0000	0.0000	(	1)
50.3333	7.0238	49.3333	(	3)
48.0000	5.2915	28.0000	(	3)
46.7143	8.3009	68.9048	(	7)

Character C35 Capitulum Total Length

mean	std dev	variance		n
10.6067	0.7126	0.5078	(	15)
10.9222	0.3193	0.1019	(	9)
10.9857	0.6262	0.3921	(	14)
11.2500	0.4707	0.2216	(	20)
9.8682	0.6090	0.3708	(	22)
10.0000	0.4163	0.1733	(	10)
9.1000	0.2828	0.0800	(	2)
9.9667	0.6543	0.4281	(	15)
11.4000	0.8888	0.7900	(	3)
10.3300	0.2793	0.0780	(	20)
12.2176	0.9580	0.9178	(	17)
11.8346	0.6046	0.3656	(	26)
12.8000	0.4243	0.1800	(	2)
13.9750	0.8955	0.8020	(	20)
13.3188	0.8976	0.8056	(	16)
13.4100	0.8522	0.7262	(	20)
13.7059	1.0609	1.1256	(	17)
14.3882	0.9048	0.8186	(	34)
13.8947	0.8663	0.7505	(	19)
14.8765	0.8371	0.7007	(	17)
12.1100	0.6332	0.4010	(	10)
10.7200	0.9818	0.9640	(	10)
12.8667	0.8386	0.7033	(	3)
12.7000	0.0000	0.0000	(	1)
9.6000	0.0000	0.0000	(	1)
12.8000	1.2728	1.6200	(	2)
13.9000	0.0000	0.0000	(	1)
16.6000	0.0000	0.0000	(	1)
13.7000	0.0000	0.0000	(	1)
14.3857	1.3629	1.8576	(	28)
11.9533	0.8245	0.6798	(	30)
14.4667	0.8402	0.7059	(	18)
13.2615	0.3948	0.1559	(	13)
12.9800	0.7050	0.4970	(	5)
12.0000	0.0000	0.0000	(	1)
14.0000	1.2166	1.4800	(	3)
13.8667	0.7024	0.4933	(	3)
15.8714	0.3817	0.1457	(	7)

Character C36 Capitulum Apex Width

mean	std dev	variance	n
3.9667	0.3579	0.1281	(15)
3.7889	0.2147	0.0461	(9)
3.9571	0.2709	0.0734	(14)
4.0750	0.1773	0.0314	(20)
4.0545	0.3113	0.0969	(22)
4.0300	0.2584	0.0668	(10)
4.2000	0.7071	0.5000	(2)
3.6333	0.2093	0.0438	(15)
4.5000	0.0000	0.0000	(3)
3.6500	0.2039	0.0416	(20)
4.2647	0.2691	0.0724	(17)
4.5077	0.4118	0.1695	(26)
8.8500	0.4950	0.2450	(2)
8.3500	0.7804	0.6089	(20)
9.9500	1.1431	1.3067	(16)
9.5250	0.9453	0.8936	(20)
8.8294	0.5818	0.3385	(17)
10.9412	1.2799	1.6383	(34)
5.9421	0.6327	0.4004	(19)
6.2059	0.5367	0.2881	(17)
4.8300	0.4968	0.2468	(10)
3.1000	0.1247	0.0156	(10)
9.6667	0.4933	0.2433	(3)
6.0000	0.0000	0.0000	(1)
7.4000	0.0000	0.0000	(1)
6.1000	0.0000	0.0000	(2)
5.9000	0.0000	0.0000	(1)
7.8000	0.0000	0.0000	(1)
7.5000	0.0000	0.0000	(1)
6.7214	1.1930	1.4232	(28)
5.4067	0.6680	0.4462	(30)
7.3333	0.6791	0.4612	(18)
6.2615	0.4556	0.2076	(13)
5.8600	0.9659	0.9330	(5)
8.4000	0.0000	0.0000	(1)
9.0000	0.3606	0.1300	(3)
8.0667	0.3215	0.1033	(3)
12.2571	0.8979	0.8062	(7)

Character C37 Capitulum Base Width

mean	std dev	variance	n
4.1733	0.3788	0.1435	(15)
4.2667	0.2121	0.0450	(9)
3.8071	0.1859	0.0346	(14)
4.0100	0.3227	0.1041	(20)
3.9045	0.2820	0.0795	(22)
3.8500	0.2991	0.0894	(10)
3.8500	0.2121	0.0450	(2)
3.6600	0.3043	0.0926	(15)
4.4000	0.1732	0.0300	(3)
3.9550	0.1395	0.0194	(20)
4.6118	0.2395	0.0574	(17)
4.4423	0.2139	0.0457	(26)
5.7000	0.2828	0.0800	(2)
5.1000	0.4920	0.2421	(20)
5.5938	0.3890	0.1513	(16)
5.6750	0.4506	0.2030	(20)
5.7529	0.6166	0.3801	(17)
5.5794	0.4650	0.2162	(34)
5.6211	0.4237	0.1795	(19)
5.8118	0.3480	0.1211	(17)
5.1700	0.2830	0.0801	(10)
3.5600	0.2591	0.0671	(10)
5.6000	0.6083	0.3700	(3)
4.7000	0.0000	0.0000	(1)
5.1000	0.0000	0.0000	(1)
4.8500	0.2121	0.0450	(2)
4.8000	0.0000	0.0000	(1)
5.2000	0.0000	0.0000	(1)
5.3000	0.0000	0.0000	(1)
5.3429	0.5996	0.3596	(28)
4.6767	0.4116	0.1694	(30)
5.4167	0.4579	0.2097	(18)
5.5769	0.3059	0.0936	(13)
5.3600	0.2074	0.0430	(5)
5.1000	0.0000	0.0000	(1)
5.0333	0.3055	0.0933	(3)
5.4333	0.4726	0.2233	(3)
6.0000	0.5508	0.3033	(7)

Character C38 Pedicel Length

mean	std dev	variance		n
9.7533	4.6080	21.2341	(	15)
6.1667	3.3275	11.0725	(	9)
4.3071	1.5390	2.3684	(	14)
9.9350	6.1858	38.2645	(	20)
4.6545	2.3938	5.7302	(	22)
1.4300	0.4322	0.1868	(	10)
3.7000	1.2728	1.6200	(	2)
4.7067	1.7657	3.1178	(	15)
6.4000	3.1512	9.9300	(	3)
8.0500	2.5297	6.3995	(	20)
4.7353	1.2649	1.5999	(	17)
5.1538	2.3811	5.6698	(	26)
10.5500	3.6062	13.0050	(	2)
16.6050	9.0997	82.8047	(	20)
18.8625	11.1535	124.3998	(	16)
15.9600	5.8061	33.7109	(	20)
19.8824	7.8287	61.2878	(	17)
24.7118	9.4622	89.5332	(	34)
20.2526	6.7352	45.3626	(	19)
14.9059	4.7259	22.3343	(	17)
14.5800	4.4083	19.4329	(	10)
9.2300	2.4940	6.2201	(	10)
12.8667	5.6589	32.0233	(	3)
7.5000	0.0000	0.0000	(	1)
4.9000	0.0000	0.0000	(	1)
9.3000	6.9296	48.0200	(	2)
5.1000	0.0000	0.0000	(	1)
4.1000	0.0000	0.0000	(	1)
4.3000	0.0000	0.0000	(	1)
12.5107	5.8412	34.1195	(	28)
10.3800	5.2055	27.0975	(	30)
4.2444	1.1418	1.3038	(	18)
9.8154	4.9285	24.2897	(	13)
18.4000	4.0181	16.1450	(	5)
5.5000	0.0000	0.0000	(	1)
10.3667	2.0306	4.1233	(	3)
10.9667	0.9609	0.9233	(	3)
16.9714	7.7768	60.4791	(	7)

character C39 Number of Phyllaries

mean	std dev	variance	n
20.1333	1.3558	1.8381	(15)
19.1111	2.4721	6.1111	(9)
20.7857	0.4258	0.1813	(14)
18.8500	1.9541	3.8184	(20)
20.3636	1.5289	2.3377	(22)
21.0000	0.0000	0.0000	(10)
21.0000	0.0000	0.0000	(2)
20.0667	1.4864	2.2095	(15)
21.6667	1.1547	1.3333	(3)
20.6000	0.8208	0.6737	(20)
20.8824	0.4851	0.2353	(17)
21.0000	0.0000	0.0000	(26)
21.0000	0.0000	0.0000	(2)
21.7500	1.2927	1.6711	(20)
21.5000	1.0328	1.0667	(16)
21.1500	0.4894	0.2395	(20)
24.1176	4.0756	16.6103	(17)
21.3824	1.0449	1.0918	(34)
20.5263	1.2188	1.4854	(19)
20.8235	0.3930	0.1544	(17)
21.0000	0.0000	0.0000	(10)
14.3000	1.2517	1.5667	(10)
22.6667	2.8868	8.3333	(3)
21.0000	0.0000	0.0000	(1)
21.0000	0.0000	0.0000	(1)
21.0000	0.0000	0.0000	(2)
21.0000	0.0000	0.0000	(1)
21.0000	0.0000	0.0000	(1)
21.0000	0.0000	0.0000	(1)
20.6429	1.0959	1.2011	(28)
20.6000	0.9685	0.9379	(30)
21.6667	1.2834	1.6471	(18)
21.1538	0.3755	0.1410	(13)
20.6000	0.8944	0.8000	(5)
21.0000	0.0000	0.0000	(1)
25.0000	0.0000	0.0000	(3)
21.6667	1.1547	1.3333	(3)
22.5714	1.8127	3.2857	(7)

Character C40 Max Phyllary Length

mean	std dev	variance		n
7.6200	0.3052	0.0931	(	15)
7.4778	0.4549	0.2069	(	9)
8.0214	0.3704	0.1372	(	14)
8.0500	0.3620	0.1311	(	20)
7.7000	0.5451	0.2971	(	22)
6.9200	0.2348	0.0551	(	10)
5.8500	0.0707	0.0050	(	2)
6.6467	0.3399	0.1155	(	15)
7.8000	0.7000	0.4900	(	3)
7.6750	0.2381	0.0567	(	20)
7.8471	0.3502	0.1226	(	17)
8.0808	0.3611	0.1304	(	26)
7.7500	0.3536	0.1250	(	2)
7.7000	0.3584	0.1284	(	20)
7.0437	0.4412	0.1946	(	16)
6.5400	0.6151	0.3783	(	20)
7.0706	0.7122	0.5072	(	17)
6.7529	0.3431	0.1177	(	34)
8.7895	0.5772	0.3332	(	19)
9.0529	0.3760	0.1414	(	17)
7.6300	0.3057	0.0934	(	10)
7.9800	0.3824	0.1462	(	10)
6.3333	0.1155	0.0133	(	3)
7.6000	0.0000	0.0000	(	1)
5.6000	0.0000	0.0000	(	1)
7.0500	0.2121	0.0450	(	2)
8.2000	0.0000	0.0000	(	1)
8.4000	0.0000	0.0000	(	1)
7.9000	0.0000	0.0000	(	1)
7.9857	0.5648	0.3190	(	28)
7.8433	0.5008	0.2508	(	30)
7.1000	0.1572	0.0247	(	18)
7.3769	0.4343	0.1886	(	13)
6.8400	0.2702	0.0730	(	5)
6.9000	0.0000	0.0000	(	1)
6.9333	0.0577	0.0033	(	3)
6.7667	0.1155	0.0133	(	3)
7.4714	0.1113	0.0124	(	7)

Character C41 Propn of Phylls with Black Tips

mean	std dev	variance	n
0.6020	0.3378	0.1141	(15)
0.6933	0.4132	0.1708	(9)
0.6321	0.2103	0.0442	(14)
0.5125	0.3479	0.1211	(20)
0.9850	0.0704	0.0049	(22)
0.2800	0.1991	0.0396	(10)
0.4500	0.3677	0.1352	(2)
0.8573	0.2087	0.0435	(15)
0.5800	0.3251	0.1057	(3)
0.6325	0.1812	0.0329	(20)
0.9524	0.1965	0.0386	(17)
0.4508	0.3364	0.1132	(26)
0.5700	0.5374	0.2888	(2)
0.9675	0.0847	0.0072	(20)
0.9169	0.1714	0.0294	(16)
0.9685	0.1084	0.0117	(20)
0.7629	0.4071	0.1657	(17)
0.8009	0.3239	0.1049	(34)
0.8432	0.3314	0.1098	(19)
1.0000	0.0000	0.0000	(17)
1.0000	0.0000	0.0000	(10)
0.0000	0.0000	0.0000	(10)
0.6267	0.4087	0.1670	(3)
1.0000	0.0000	0.0000	(1)
0.0000	0.0000	0.0000	(1)
0.0000	0.0000	0.0000	(2)
1.0000	0.0000	0.0000	(1)
0.7600	0.0000	0.0000	(1)
0.1900	0.0000	0.0000	(1)
0.7246	0.3311	0.1096	(28)
0.9187	0.1788	0.0320	(30)
0.7206	0.2280	0.0520	(18)
1.0000	0.0000	0.0000	(13)
1.0000	0.0000	0.0000	(5)
0.2900	0.0000	0.0000	(1)
0.8000	0.2000	0.0400	(3)
1.0000	0.0000	0.0000	(3)
0.9586	0.0623	0.0039	(7)

Character C421 SQRT Max Phyll Hair Density

mean	std dev	variance		n
0.4667	0.5164	0.2667	(	15)
0.2222	0.4410	0.1944	(	9)
0.3571	0.4972	0.2473	(	14)
0.0500	0.2236	0.0500	(	20)
0.0455	0.2132	0.0455	(	22)
0.0000	0.0000	0.0000	(	10)
0.5000	0.7071	0.5000	(	2)
0.0667	0.2582	0.0667	(	15)
0.3333	0.5774	0.3333	(	3)
0.9328	0.4350	0.1893	(	20)
0.4361	0.5458	0.2979	(	17)
0.1154	0.3258	0.1062	(	26)
0.0000	0.0000	0.0000	(	2)
2.5243	0.7455	0.5557	(	20)
1.2478	0.7342	0.5391	(	16)
1.1500	0.5872	0.3448	(	20)
0.7475	0.6848	0.4689	(	17)
0.6147	0.6069	0.3683	(	34)
0.5558	0.6294	0.3961	(	19)
0.2008	0.4551	0.2071	(	17)
0.3414	0.5612	0.3149	(	10)
8.2653	0.6539	0.4276	(	10)
6.2629	0.4051	0.1641	(	3)
0.0000	0.0000	0.0000	(	1)
0.0000	0.0000	0.0000	(	1)
1.0000	0.0000	0.0000	(	2)
0.0000	0.0000	0.0000	(	1)
0.0000	0.0000	0.0000	(	1)
1.0000	0.0000	0.0000	(	1)
0.2082	0.4630	0.2143	(	28)
0.2667	0.4498	0.2023	(	30)
0.3415	0.5892	0.3471	(	18)
0.3396	0.5401	0.2918	(	13)
0.4000	0.5477	0.3000	(	5)
0.0000	0.0000	0.0000	(	1)
0.6667	0.5774	0.3333	(	3)
0.0000	0.0000	0.0000	(	3)
0.1429	0.3780	0.1429	(	7)

Character C431 SQRT Max Phyll Gland Density

mean	std dev	variance		n
0.8959	0.8000	0.6400	(	15)
0.3333	0.5000	0.2500	(	9)
1.0086	0.6049	0.3659	(	14)
0.3000	0.4702	0.2211	(	20)
0.8902	0.8037	0.6459	(	22)
0.0000	0.0000	0.0000	(	10)
0.7071	1.0000	1.0000	(	2)
0.2000	0.4140	0.1714	(	15)
1.2761	0.2391	0.0572	(	3)
1.7811	0.3668	0.1346	(	20)
3.8671	0.4160	0.1731	(	17)
2.9888	0.3311	0.1096	(	26)
3.2071	2.5355	6.4289	(	2)
5.4072	0.4722	0.2230	(	20)
4.4003	0.8244	0.6796	(	16)
5.2213	0.8815	0.7771	(	20)
5.1302	0.5351	0.2864	(	17)
4.1308	1.2290	1.5105	(	34)
0.7665	0.9671	0.9354	(	19)
3.2975	0.3669	0.1346	(	17)
15.2154	0.6600	0.4355	(	10)
7.6743	0.5817	0.3384	(	10)
5.1417	0.5870	0.3446	(	3)
2.2361	0.0000	0.0000	(	1)
3.6056	0.0000	0.0000	(	1)
4.4707	1.4235	2.0263	(	2)
2.4495	0.0000	0.0000	(	1)
3.7417	0.0000	0.0000	(	1)
3.6056	0.0000	0.0000	(	1)
2.9824	1.1376	1.2942	(	28)
2.7241	0.5044	0.2544	(	30)
1.8495	1.1988	1.4370	(	18)
11.9265	0.6367	0.4054	(	13)
11.8995	0.5011	0.2511	(	5)
3.4641	0.0000	0.0000	(	1)
2.8509	0.5555	0.3086	(	3)
0.0000	0.0000	0.0000	(	3)
1.5039	1.4240	2.0279	(	7)

Character C44 No of Calyculus Bracts

mean	std dev	variance		n
11.6000	1.9928	3.9714	(	15)
11.7778	2.8186	7.9444	(	9)
12.0714	2.0555	4.2253	(	14)
11.8000	3.1556	9.9579	(	20)
12.5455	2.4828	6.1645	(	22)
14.1000	1.2867	1.6556	(	10)
16.5000	0.7071	0.5000	(	2)
13.4667	2.4456	5.9810	(	15)
17.3333	2.8868	8.3333	(	3)
11.3500	1.1367	1.2921	(	20)
19.4118	3.2988	10.8824	(	17)
15.9231	1.1974	1.4338	(	26)
9.0000	1.4142	2.0000	(	2)
7.9000	1.5526	2.4105	(	20)
8.3750	2.1871	4.7833	(	16)
9.7000	1.5252	2.3263	(	20)
10.2941	3.7377	13.9706	(	17)
9.0000	1.8257	3.3333	(	34)
9.2632	1.9103	3.6491	(	19)
11.4706	1.9403	3.7647	(	17)
5.8000	0.4216	0.1778	(	10)
3.6000	0.5164	0.2667	(	10)
15.3333	1.1547	1.3333	(	3)
8.0000	0.0000	0.0000	(	1)
8.0000	0.0000	0.0000	(	1)
20.5000	2.1213	4.5000	(	2)
18.0000	0.0000	0.0000	(	1)
12.0000	0.0000	0.0000	(	1)
8.0000	0.0000	0.0000	(	1)
10.5000	2.5313	6.4074	(	28)
11.5333	2.3154	5.3609	(	30)
12.6667	1.4951	2.2353	(	18)
5.3846	0.7679	0.5897	(	13)
6.0000	0.7071	0.5000	(	5)
16.0000	0.0000	0.0000	(	1)
9.0000	1.0000	1.0000	(	3)
10.3333	2.5166	6.3333	(	3)
9.7143	1.1127	1.2381	(	7)

Character C45 No of Pedicel Bracts

mean	std dev	variance		n
1.0667	0.9612	0.9238	(	15)
0.2222	0.4410	0.1944	(	9)
1.7143	0.8254	0.6813	(	14)
1.2500	0.6387	0.4079	(	20)
1.3182	0.9946	0.9892	(	22)
1.2000	1.0328	1.0667	(	10)
1.0000	1.4142	2.0000	(	2)
1.0000	0.8452	0.7143	(	15)
1.0000	1.0000	1.0000	(	3)
2.2000	0.6156	0.3789	(	20)
6.4706	3.3000	10.8897	(	17)
4.4615	2.2668	5.1385	(	26)
2.0000	0.0000	0.0000	(	2)
5.1500	1.9270	3.7132	(	20)
3.6250	2.7295	7.4500	(	16)
3.3000	0.9234	0.8526	(	20)
8.8235	7.9627	63.4044	(	17)
4.2941	4.1380	17.1230	(	34)
2.6316	1.1648	1.3567	(	19)
2.5882	1.1757	1.3824	(	17)
2.5000	0.5270	0.2778	(	10)
1.5000	0.7071	0.5000	(	10)
6.0000	2.0000	4.0000	(	3)
2.0000	0.0000	0.0000	(	1)
1.0000	0.0000	0.0000	(	1)
6.0000	4.2426	18.0000	(	2)
5.0000	0.0000	0.0000	(	1)
2.0000	0.0000	0.0000	(	1)
2.0000	0.0000	0.0000	(	1)
2.4286	1.0338	1.0688	(	28)
1.5000	0.8200	0.6724	(	30)
2.0556	0.6391	0.4085	(	18)
2.0769	0.8623	0.7436	(	13)
2.4000	0.5477	0.3000	(	5)
3.0000	0.0000	0.0000	(	1)
3.6667	1.1547	1.3333	(	3)
5.3333	4.0415	16.3333	(	3)
5.2857	2.9841	8.9048	(	7)

Character C461 SQRT Mean Calyc Bract Hair Density

mean	std dev	variance	n
0.8845	0.2883	0.0831	(15)
0.8466	0.2088	0.0436	(9)
0.6187	0.2691	0.0724	(14)
0.5686	0.3107	0.0965	(20)
0.7388	0.3002	0.0901	(22)
1.1719	0.2279	0.0519	(10)
0.4320	0.1637	0.0268	(2)
0.6437	0.2514	0.0632	(15)
1.4190	0.2825	0.0798	(3)
0.6315	0.1493	0.0223	(20)
2.3207	0.5025	0.2525	(17)
3.7213	0.8212	0.6743	(26)
1.7493	0.2830	0.0801	(2)
1.3521	0.3355	0.1126	(20)
0.7923	0.3878	0.1504	(16)
0.3448	0.2536	0.0643	(20)
1.0649	0.2401	0.0577	(17)
0.6122	0.4690	0.2200	(34)
0.4559	0.2043	0.0417	(19)
0.2150	0.1959	0.0384	(17)
1.2246	0.3341	0.1116	(10)
6.9101	0.5066	0.2567	(10)
4.6537	0.6441	0.4149	(3)
0.7746	0.0000	0.0000	(1)
0.0000	0.0000	0.0000	(1)
0.7482	0.2835	0.0804	(2)
1.9494	0.0000	0.0000	(1)
0.9487	0.0000	0.0000	(1)
1.1832	0.0000	0.0000	(1)
0.8194	0.3651	0.1333	(28)
0.9339	0.2447	0.0599	(30)
0.4048	0.1215	0.0148	(18)
1.6634	0.6410	0.4109	(13)
1.3430	0.4954	0.2454	(5)
1.0000	0.0000	0.0000	(1)
0.1491	0.2582	0.0667	(3)
1.8741	0.3631	0.1319	(3)
0.3251	0.2450	0.0600	(7)

Character C471 SQRT Mean Calyc Bract Gland density

mean	std dev	variance	n
0.2890	0.2311	0.0534	(15)
0.0703	0.1394	0.0194	(9)
0.1449	0.1768	0.0312	(14)
0.2437	0.1795	0.0322	(20)
0.4347	0.1452	0.0211	(22)
0.4697	0.1021	0.0104	(10)
0.3817	0.0926	0.0086	(2)
0.3522	0.1307	0.0171	(15)
1.0197	0.5387	0.2902	(3)
0.4523	0.1466	0.0215	(20)
1.3707	0.2916	0.0850	(17)
1.7859	0.2427	0.0589	(26)
0.1581	0.2236	0.0500	(2)
1.9952	0.5518	0.3045	(20)
0.9856	0.5265	0.2772	(16)
0.3097	0.2274	0.0517	(20)
1.3633	0.7584	0.5752	(17)
0.4116	0.3790	0.1436	(34)
0.2214	0.2437	0.0594	(19)
0.4804	0.1049	0.0110	(17)
10.8106	0.3662	0.1341	(10)
1.6177	0.5897	0.3478	(10)
1.6016	0.0479	0.0023	(3)
0.0000	0.0000	0.0000	(1)
0.0000	0.0000	0.0000	(1)
1.2808	0.1380	0.0190	(2)
1.6125	0.0000	0.0000	(1)
0.4472	0.0000	0.0000	(1)
0.7071	0.0000	0.0000	(1)
1.0134	0.6568	0.4314	(28)
0.7734	0.2968	0.0881	(30)
0.4854	0.1970	0.0388	(18)
8.6285	0.7387	0.5456	(13)
8.6234	0.8640	0.7464	(5)
0.5477	0.0000	0.0000	(1)
0.1054	0.1826	0.0333	(3)
1.9358	0.4229	0.1788	(3)
0.8098	0.4846	0.2348	(7)

Character C48 Mean Calyc Bract Length

mean	std dev	variance		n
2.6707	0.3420	0.1170	(	15)
2.8344	0.3386	0.1146	(	9)
2.3757	0.1183	0.0140	(	14)
3.7040	0.2271	0.0516	(	20)
2.9477	0.3394	0.1152	(	22)
2.8640	0.1892	0.0358	(	10)
2.6100	0.1556	0.0242	(	2)
2.4507	0.3173	0.1007	(	15)
2.7900	0.3857	0.1488	(	3)
2.6205	0.2049	0.0420	(	20)
2.2865	0.1753	0.0307	(	17)
2.8896	0.1748	0.0305	(	26)
2.7950	0.0919	0.0084	(	2)
3.8130	0.2624	0.0689	(	20)
3.0106	0.4047	0.1638	(	16)
2.8765	0.3023	0.0914	(	20)
3.0847	0.4639	0.2152	(	17)
3.6300	0.6210	0.3856	(	34)
4.4047	0.3947	0.1558	(	19)
4.1453	0.2970	0.0882	(	17)
5.1760	0.3283	0.1078	(	10)
2.2640	0.1604	0.0257	(	10)
2.6033	0.3408	0.1161	(	3)
2.9000	0.0000	0.0000	(	1)
3.0800	0.0000	0.0000	(	1)
2.7200	0.7212	0.5202	(	2)
3.1200	0.0000	0.0000	(	1)
3.4000	0.0000	0.0000	(	1)
3.5800	0.0000	0.0000	(	1)
4.0704	0.5747	0.3303	(	28)
3.3227	0.4496	0.2022	(	30)
3.0711	0.2040	0.0416	(	18)
3.9500	0.3550	0.1260	(	13)
3.7020	0.3359	0.1128	(	5)
3.2200	0.0000	0.0000	(	1)
3.5333	0.0513	0.0026	(	3)
3.1733	0.1210	0.0146	(	3)
4.1600	0.3694	0.1364	(	7)

Character C49 Range Calyc Bract Length

mean	std dev	variance	n
1.7200	1.0449	1.0917	(15)
1.2222	0.6016	0.3619	(9)
0.8714	0.2577	0.0664	(14)
1.5025	0.5235	0.2741	(20)
1.1705	0.5658	0.3202	(22)
0.9050	0.3912	0.1530	(10)
2.0750	0.4596	0.2113	(2)
1.6333	0.7396	0.5470	(15)
1.1333	0.3055	0.0933	(3)
0.9250	0.8034	0.6454	(20)
0.8912	0.2623	0.0688	(17)
0.6692	0.1955	0.0382	(26)
0.8500	0.7778	0.6050	(2)
0.6275	0.2643	0.0699	(20)
0.9344	0.4400	0.1936	(16)
0.8300	0.4447	0.1977	(20)
0.9118	0.6575	0.4324	(17)
0.8235	0.4831	0.2334	(34)
1.3711	0.7934	0.6295	(19)
1.5529	0.7290	0.5314	(17)
0.7300	0.2869	0.0823	(10)
0.4300	0.2058	0.0423	(10)
0.5000	0.1000	0.0100	(3)
0.7000	0.0000	0.0000	(1)
1.1000	0.0000	0.0000	(1)
1.8500	0.0000	0.0000	(2)
0.6000	0.0000	0.0000	(1)
1.2500	0.0000	0.0000	(1)
0.7000	0.0000	0.0000	(1)
1.1625	0.5638	0.3179	(28)
1.2400	0.7930	0.6289	(30)
1.0444	0.4003	0.1603	(18)
0.7923	0.3499	0.1224	(13)
0.8000	0.4301	0.1850	(5)
0.9000	0.0000	0.0000	(1)
0.7833	0.2309	0.0533	(3)
0.5000	0.1732	0.0300	(3)
0.8286	0.3264	0.1065	(7)

Character C50 Mean Calyc Bract Width

mean	std dev	variance	n
0.6060	0.0426	0.0018	(15)
0.6156	0.0621	0.0039	(9)
0.6257	0.0554	0.0031	(14)
0.6060	0.0591	0.0035	(20)
0.6141	0.0419	0.0018	(22)
0.5570	0.0216	0.0005	(10)
0.5650	0.0212	0.0004	(2)
0.5247	0.0524	0.0027	(15)
0.5100	0.0436	0.0019	(3)
0.5175	0.0454	0.0021	(20)
0.4988	0.0437	0.0019	(17)
0.5665	0.0246	0.0006	(26)
0.5300	0.0424	0.0018	(2)
0.5350	0.0521	0.0027	(20)
0.6156	0.0610	0.0037	(16)
0.5115	0.0643	0.0041	(20)
0.5018	0.0891	0.0079	(17)
0.6250	0.0778	0.0061	(34)
0.8189	0.0780	0.0061	(19)
0.8024	0.0641	0.0041	(17)
0.5270	0.0411	0.0017	(10)
0.4200	0.0445	0.0020	(10)
0.4933	0.0208	0.0004	(3)
0.6000	0.0000	0.0000	(1)
0.6400	0.0000	0.0000	(1)
0.4350	0.0919	0.0084	(2)
0.5400	0.0000	0.0000	(1)
0.6400	0.0000	0.0000	(1)
0.6400	0.0000	0.0000	(1)
0.8375	0.8403	0.7062	(28)
0.6757	0.0611	0.0037	(30)
0.6083	0.0329	0.0011	(18)
0.5323	0.0666	0.0044	(13)
0.5160	0.0817	0.0067	(5)
0.6900	0.0000	0.0000	(1)
0.5600	0.0400	0.0016	(3)
0.4867	0.0208	0.0004	(3)
0.6200	0.0554	0.0031	(7)

Character C51 Calyc Bract Black Tip Max Length

mean	std dev	variance	n
0.7167	0.2250	0.0506	(9)
0.8857	0.0602	0.0036	(14)
0.5000	0.0562	0.0032	(20)
1.0109	0.2435	0.0593	(22)
0.4700	0.0422	0.0018	(10)
0.8000	0.0707	0.0050	(2)
1.1867	0.2022	0.0409	(15)
0.4667	0.1155	0.0133	(3)
1.0975	0.1517	0.0230	(20)
0.5794	0.0867	0.0075	(17)
0.4962	0.1183	0.0140	(26)
0.8500	0.0707	0.0050	(2)
0.7525	0.1446	0.0209	(20)
0.8187	0.1448	0.0210	(16)
0.7925	0.0878	0.0077	(20)
1.0235	1.2877	1.6582	(17)
0.9103	0.2642	0.0698	(34)
0.7289	0.2299	0.0529	(19)
1.0206	0.1225	0.0150	(17)
0.5400	0.0568	0.0032	(10)
0.0000	0.0000	0.0000	(10)
0.7500	0.0500	0.0025	(3)
1.1000	0.0000	0.0000	(1)
0.0000	0.0000	0.0000	(1)
0.6750	0.2475	0.0613	(2)
0.7000	0.0000	0.0000	(1)
1.3500	0.0000	0.0000	(1)
1.0500	0.0000	0.0000	(1)
0.9286	0.2777	0.0771	(28)
1.1450	0.2379	0.0566	(30)
0.9250	0.1191	0.0142	(18)
0.8231	0.0992	0.0098	(13)
0.7000	0.0791	0.0063	(5)
0.9500	0.0000	0.0000	(1)
0.8833	0.0764	0.0058	(3)
0.9833	0.0289	0.0008	(3)
0.9500	0.1080	0.0117	(7)

Character C52 Calyc Bract Black Tip Max Width

mean	std dev	variance	n
0.2933	0.0495	0.0025	(15)
0.3889	0.1577	0.0249	(9)
0.3879	0.0289	0.0008	(14)
0.2615	0.0386	0.0015	(20)
0.3636	0.0468	0.0022	(22)
0.1950	0.0158	0.0002	(10)
0.4500	0.0000	0.0000	(2)
0.4067	0.0530	0.0028	(15)
0.2000	0.0500	0.0025	(3)
0.4350	0.0540	0.0029	(20)
0.1576	0.0325	0.0011	(17)
0.1615	0.0431	0.0019	(26)
0.3000	0.0000	0.0000	(2)
0.2715	0.0496	0.0025	(20)
0.3656	0.0437	0.0019	(16)
0.3650	0.0489	0.0024	(20)
0.3047	0.0637	0.0041	(17)
0.3456	0.0995	0.0099	(34)
0.3737	0.0903	0.0082	(19)
0.4500	0.0829	0.0069	(17)
0.2100	0.0211	0.0004	(10)
0.0000	0.0000	0.0000	(10)
0.1667	0.0289	0.0008	(3)
0.3500	0.0000	0.0000	(1)
0.0000	0.0000	0.0000	(1)
0.2250	0.0354	0.0012	(2)
0.2000	0.0000	0.0000	(1)
0.4000	0.0000	0.0000	(1)
0.3500	0.0000	0.0000	(1)
0.3357	0.0665	0.0044	(28)
0.4083	0.0696	0.0048	(30)
0.4528	0.0436	0.0019	(18)
0.2615	0.0416	0.0017	(13)
0.2500	0.0354	0.0013	(5)
0.3000	0.0000	0.0000	(1)
0.3000	0.0000	0.0000	(3)
0.2500	0.0000	0.0000	(3)
0.3286	0.0488	0.0024	(7)

Character C53 Number of Disc Florets

mean	std dev	variance		n
53.0000	6.9179	47.8571	(	15)
53.3333	8.0467	64.7500	(	9)
55.0714	4.2329	17.9176	(	14)
53.4500	4.8501	23.5237	(	20)
58.4545	6.4197	41.2121	(	22)
58.1000	3.3483	11.2111	(	10)
72.0000	11.3137	128.0000	(	2)
44.0667	5.6627	32.0667	(	15)
56.6667	5.1316	26.3333	(	3)
44.3500	4.2831	18.3447	(	20)
60.1176	7.3645	54.2353	(	17)
58.1154	7.3339	53.7862	(	26)
70.0000	8.4853	72.0000	(	2)
74.9000	7.4403	55.3579	(	20)
93.3750	12.6590	160.2500	(	16)
99.1500	9.4271	88.8711	(	20)
90.3529	27.6924	766.8676	(	17)
08.6176	17.6824	312.6676	(	34)
53.3684	8.6101	74.1345	(	19)
65.8824	3.9668	15.7353	(	17)
54.5000	3.3082	10.9444	(	10)
49.0000	2.5386	6.4444	(	10)
93.0000	21.6333	468.0000	(	3)
61.0000	0.0000	0.0000	(	1)
84.0000	0.0000	0.0000	(	1)
87.5000	6.3640	40.5000	(	2)
64.0000	0.0000	0.0000	(	1)
71.0000	0.0000	0.0000	(	1)
78.0000	0.0000	0.0000	(	1)
74.6071	13.2451	175.4325	(	28)
63.7667	9.9505	99.0126	(	30)
91.5000	8.0018	64.0294	(	18)
76.7692	6.6100	43.6923	(	13)
75.0000	10.7703	116.0000	(	5)
97.0000	0.0000	0.0000	(	1)
08.3333	18.5831	345.3333	(	3)
11.0000	13.0000	169.0000	(	3)
88.4286	20.1813	407.2857	(	7)

Character C54 Mean Disc Floret Total Length

mean	std dev	variance	n
7.3193	0.4219	0.1780	(15)
7.6100	0.3721	0.1385	(9)
7.7229	0.3628	0.1317	(14)
7.5370	0.3573	0.1277	(20)
7.4505	0.3598	0.1294	(22)
7.3960	0.4407	0.1942	(10)
6.4950	0.1768	0.0313	(2)
6.8427	0.2741	0.0751	(15)
8.3200	0.4504	0.2029	(3)
7.9390	0.1753	0.0307	(20)
9.0218	0.5168	0.2671	(17)
9.0508	0.3792	0.1438	(26)
8.4000	0.6081	0.3698	(2)
9.4035	0.4523	0.2046	(20)
8.8400	0.5921	0.3506	(16)
8.7240	0.3856	0.1487	(20)
8.7588	0.8036	0.6457	(17)
9.6082	0.4705	0.2214	(34)
10.1405	0.5258	0.2765	(19)
10.5200	0.4310	0.1858	(17)
8.1930	0.5309	0.2818	(10)
7.4900	0.3589	0.1288	(10)
9.1067	0.5597	0.3132	(3)
8.1600	0.0000	0.0000	(1)
6.4900	0.0000	0.0000	(1)
8.5150	0.7000	0.4900	(2)
9.1700	0.0000	0.0000	(1)
10.1000	0.0000	0.0000	(1)
9.7200	0.0000	0.0000	(1)
9.7336	0.7876	0.6203	(28)
8.7240	0.6384	0.4075	(30)
9.5000	0.2663	0.0709	(18)
9.0077	0.4459	0.1989	(13)
8.5220	0.4630	0.2144	(5)
8.3900	0.0000	0.0000	(1)
9.2833	0.4856	0.2358	(3)
9.4800	0.2117	0.0448	(3)
10.9414	0.2836	0.0804	(7)

Character C55 Mean Disc Floret Corolla Tube Length

mean	std dev	variance	n
1.9027	0.0941	0.0089	(15)
2.0889	0.1072	0.0115	(9)
2.0586	0.1038	0.0108	(14)
1.9140	0.0746	0.0056	(20)
1.9964	0.0968	0.0094	(22)
2.1280	0.0766	0.0059	(10)
1.8500	0.0990	0.0098	(2)
1.9060	0.0658	0.0043	(15)
2.2933	0.1069	0.0114	(3)
2.3025	0.1025	0.0105	(20)
2.3176	0.1290	0.0166	(17)
2.5704	0.1433	0.0205	(26)
3.7900	0.2404	0.0578	(2)
3.3265	0.1320	0.0174	(20)
3.4762	0.1993	0.0397	(16)
3.4595	0.1562	0.0244	(20)
3.3459	0.1376	0.0189	(17)
3.7138	0.2508	0.0629	(34)
3.0974	0.1433	0.0205	(19)
3.2029	0.0874	0.0076	(17)
2.4120	0.1129	0.0128	(10)
1.4640	0.0481	0.0023	(10)
2.8000	0.1015	0.0103	(3)
2.5900	0.0000	0.0000	(1)
2.3900	0.0000	0.0000	(1)
2.8300	0.0990	0.0098	(2)
2.9100	0.0000	0.0000	(1)
3.0500	0.0000	0.0000	(1)
3.3400	0.0000	0.0000	(1)
3.2679	0.3606	0.1300	(28)
2.6973	0.2682	0.0719	(30)
3.0728	0.1025	0.0105	(18)
2.6155	0.7074	0.5004	(13)
2.7760	0.0882	0.0078	(5)
2.8900	0.0000	0.0000	(1)
3.4400	0.0800	0.0064	(3)
3.3300	0.1493	0.0223	(3)
4.2086	0.1463	0.0214	(7)

Character C56 Mean Disc Floret Corolla Tube Width

mean	std dev	variance	n
0.7073	0.0489	0.0024	(15)
0.7500	0.0612	0.0038	(9)
0.7007	0.0450	0.0020	(14)
0.6690	0.0567	0.0032	(20)
0.6545	0.0489	0.0024	(22)
0.6500	0.0392	0.0015	(10)
0.6750	0.0354	0.0013	(2)
0.6807	0.0511	0.0026	(15)
0.8167	0.1155	0.0133	(3)
0.7485	0.0502	0.0025	(20)
0.7353	0.0996	0.0099	(17)
0.7681	0.0818	0.0067	(26)
1.6250	0.1768	0.0313	(2)
1.4360	0.0786	0.0062	(20)
1.5987	0.0618	0.0038	(16)
1.5600	0.1107	0.0123	(20)
1.6294	0.1263	0.0160	(17)
1.6574	0.0889	0.0079	(34)
1.1184	0.0768	0.0059	(19)
1.1382	0.0416	0.0017	(17)
1.0250	0.0717	0.0051	(10)
0.6500	0.0408	0.0017	(10)
1.5500	0.1323	0.0175	(3)
1.1000	0.0000	0.0000	(1)
1.3000	0.0000	0.0000	(1)
1.1500	0.0707	0.0050	(2)
1.1500	0.0000	0.0000	(1)
1.2000	0.0000	0.0000	(1)
1.2500	0.0000	0.0000	(1)
1.2232	0.1475	0.0218	(28)
1.0143	0.1140	0.0130	(30)
1.1000	0.0955	0.0091	(18)
1.1269	0.0881	0.0078	(13)
1.0900	0.0418	0.0018	(5)
1.1500	0.0000	0.0000	(1)
1.6500	0.0500	0.0025	(3)
1.4167	0.0289	0.0008	(3)
1.9286	0.0488	0.0024	(7)

Character C57 Anther Length

mean	std dev	variance		n
1.2367	0.0581	0.0034	(	15)
1.2833	0.0791	0.0062	(	9)
1.1607	0.0446	0.0020	(	14)
1.1425	0.0545	0.0030	(	20)
1.1886	0.0510	0.0026	(	22)
1.1750	0.0486	0.0024	(	10)
1.1750	0.0354	0.0013	(	2)
1.1933	0.0594	0.0035	(	15)
1.4500	0.0866	0.0075	(	3)
1.5050	0.0686	0.0047	(	20)
1.5588	0.0795	0.0063	(	17)
1.5173	0.0547	0.0030	(	26)
2.9000	0.2121	0.0450	(	2)
2.5025	0.1094	0.0120	(	20)
2.5125	0.0904	0.0082	(	16)
2.5775	0.0966	0.0093	(	20)
2.4324	0.1960	0.0384	(	17)
2.6059	0.1526	0.0233	(	34)
2.1368	0.0984	0.0097	(	19)
2.2147	0.0552	0.0031	(	17)
1.8400	0.0516	0.0027	(	10)
1.3950	0.0369	0.0014	(	10)
1.8333	0.1041	0.0108	(	3)
1.8000	0.0000	0.0000	(	1)
1.6500	0.0000	0.0000	(	1)
2.0500	0.2121	0.0450	(	2)
2.0000	0.0000	0.0000	(	1)
2.1500	0.0000	0.0000	(	1)
2.4000	0.0000	0.0000	(	1)
2.2321	0.2678	0.0717	(	28)
1.8217	0.1789	0.0320	(	30)
2.3167	0.0891	0.0079	(	18)
2.1000	0.0577	0.0033	(	13)
2.0900	0.0652	0.0043	(	5)
2.1000	0.0000	0.0000	(	1)
2.5500	0.1323	0.0175	(	3)
2.4333	0.0289	0.0008	(	3)
3.1071	0.0673	0.0045	(	7)

Character C58 Number of Ray Florets

mean	std dev	variance		n
0.0000	0.0000	0.0000	(	15)
0.0000	0.0000	0.0000	(	9)
0.0000	0.0000	0.0000	(	14)
0.0000	0.0000	0.0000	(	20)
0.0000	0.0000	0.0000	(	22)
0.0000	0.0000	0.0000	(	10)
0.0000	0.0000	0.0000	(	2)
9.0667	1.6676	2.7810	(	15)
10.0000	1.7321	3.0000	(	3)
9.0000	1.4868	2.2105	(	20)
10.5294	2.2113	4.8897	(	17)
11.1538	1.8263	3.3354	(	26)
13.0000	0.0000	0.0000	(	2)
13.0000	0.4588	0.2105	(	20)
12.8750	0.3416	0.1167	(	16)
8.2000	6.2205	38.6947	(	20)
13.0000	1.3229	1.7500	(	17)
12.1765	1.6601	2.7558	(	34)
8.6316	3.4994	12.2456	(	19)
11.2353	3.0929	9.5662	(	17)
13.1000	0.3162	0.1000	(	10)
10.5000	1.0801	1.1667	(	10)
12.6667	0.5774	0.3333	(	3)
10.0000	0.0000	0.0000	(	1)
12.0000	0.0000	0.0000	(	1)
13.0000	0.0000	0.0000	(	2)
13.0000	0.0000	0.0000	(	1)
12.0000	0.0000	0.0000	(	1)
12.0000	0.0000	0.0000	(	1)
11.0714	1.8445	3.4021	(	28)
10.7333	1.8925	3.5816	(	30)
13.2778	0.4609	0.2124	(	18)
13.8462	1.3445	1.8077	(	13)
12.8000	1.0954	1.2000	(	5)
10.0000	0.0000	0.0000	(	1)
14.3333	1.5275	2.3333	(	3)
13.0000	0.0000	0.0000	(	3)
9.7143	2.9277	8.5714	(	7)

Character C59 Mean Outer Floret length

mean	std dev	variance	n
1.7540	0.0661	0.0044	(15)
1.9200	0.0495	0.0025	(9)
1.8679	0.0368	0.0014	(14)
1.8185	0.0639	0.0041	(20)
1.8227	0.0605	0.0037	(22)
1.8580	0.0673	0.0045	(10)
1.7700	0.0141	0.0002	(2)
4.6727	0.1444	0.0209	(15)
4.4367	0.8271	0.6841	(3)
5.5820	0.1734	0.0301	(20)
3.2418	0.2410	0.0581	(17)
4.0573	0.2552	0.0651	(26)
11.4100	1.4991	2.2472	(2)
12.0395	0.8659	0.7498	(20)
11.8769	1.1422	1.3047	(16)
6.2400	3.0752	9.4567	(20)
10.0912	1.7175	2.9499	(17)
12.4059	1.3539	1.8330	(34)
4.6253	1.9978	3.9913	(19)
6.8594	1.1795	1.3913	(17)
5.9090	0.4037	0.1630	(10)
3.5490	0.1990	0.0396	(10)
10.8900	0.2553	0.0652	(3)
5.2300	0.0000	0.0000	(1)
6.6400	0.0000	0.0000	(1)
8.0300	0.8768	0.7688	(2)
4.4800	0.0000	0.0000	(1)
3.6600	0.0000	0.0000	(1)
10.3900	0.0000	0.0000	(1)
9.5261	2.3477	5.5115	(28)
3.8760	0.6588	0.4340	(30)
9.7356	0.6139	0.3769	(18)
7.6215	0.8711	0.7588	(13)
7.2780	0.6821	0.4653	(5)
8.1100	0.0000	0.0000	(1)
13.2100	0.5703	0.3252	(3)
12.2667	0.9090	0.8262	(3)
17.4143	0.5912	0.3495	(7)

Character C60 Range Outer Floret Length

mean	std dev	variance		n
0.2567	0.0495	0.0025	(	15)
0.2444	0.0527	0.0028	(	9)
0.2429	0.0646	0.0042	(	14)
0.2300	0.0571	0.0033	(	20)
0.2568	0.0541	0.0029	(	22)
0.2500	0.0527	0.0028	(	10)
0.2500	0.0707	0.0050	(	2)
0.4267	0.1280	0.0164	(	15)
0.4667	0.2082	0.0433	(	3)
0.5500	0.2947	0.0868	(	20)
0.3353	0.1115	0.0124	(	17)
0.4346	0.1853	0.0344	(	26)
1.1500	0.4950	0.2450	(	2)
1.3450	0.4078	0.1663	(	20)
1.1500	0.4033	0.1627	(	16)
0.6050	0.3706	0.1373	(	20)
1.1824	0.9645	0.9303	(	17)
1.3088	0.5341	0.2852	(	34)
0.4921	0.2238	0.0501	(	19)
0.5412	0.1460	0.0213	(	17)
0.6800	0.1619	0.0262	(	10)
0.5700	0.1567	0.0246	(	10)
1.0667	0.0577	0.0033	(	3)
0.5000	0.0000	0.0000	(	1)
1.0000	0.0000	0.0000	(	1)
0.5500	0.0707	0.0050	(	2)
0.5000	0.0000	0.0000	(	1)
0.3000	0.0000	0.0000	(	1)
1.3000	0.0000	0.0000	(	1)
1.0250	0.4904	0.2405	(	28)
0.4400	0.1632	0.0266	(	30)
0.7389	0.2477	0.0613	(	18)
0.7538	0.3099	0.0960	(	13)
1.1000	0.3536	0.1250	(	5)
1.0000	0.0000	0.0000	(	1)
1.0667	0.5033	0.2533	(	3)
1.0667	0.0577	0.0033	(	3)
2.0429	0.5396	0.2912	(	7)

Character C61 Mean Outer Floret Width

mean	std dev	variance		n
0.7167	0.0261	0.0007	(	15)
0.7556	0.0309	0.0010	(	9)
0.7936	0.0403	0.0016	(	14)
0.8120	0.0953	0.0091	(	20)
0.8018	0.0540	0.0029	(	22)
0.9020	0.0439	0.0019	(	10)
0.9200	0.0424	0.0018	(	2)
1.1427	0.0757	0.0057	(	15)
1.4767	0.1601	0.0256	(	3)
1.2290	0.0863	0.0075	(	20)
1.0506	0.0972	0.0094	(	17)
1.0619	0.0707	0.0050	(	26)
3.5800	0.0424	0.0018	(	2)
2.7035	0.3706	0.1374	(	20)
3.1894	0.2911	0.0847	(	16)
2.2790	0.6057	0.3669	(	20)
2.9576	0.4224	0.1784	(	17)
3.1371	0.3677	0.1352	(	34)
1.8537	0.4380	0.1918	(	19)
1.9253	0.1597	0.0255	(	17)
0.8950	0.0897	0.0081	(	10)
0.7510	0.0367	0.0013	(	10)
3.4800	0.2352	0.0553	(	3)
1.6600	0.0000	0.0000	(	1)
2.0100	0.0000	0.0000	(	1)
2.0350	0.2475	0.0613	(	2)
1.3300	0.0000	0.0000	(	1)
1.5800	0.0000	0.0000	(	1)
2.4700	0.0000	0.0000	(	1)
2.3468	0.4983	0.2483	(	28)
1.4890	0.2061	0.0425	(	30)
2.4811	0.1690	0.0286	(	18)
1.6531	0.1374	0.0189	(	13)
1.5820	0.0993	0.0099	(	5)
2.2400	0.0000	0.0000	(	1)
2.4967	0.3156	0.0996	(	3)
3.6500	0.2666	0.0711	(	3)
4.0700	0.3697	0.1367	(	7)

Character C62 Outer Floret Ray Gland Density

mean	std dev	variance		n
0.0000	0.0000	0.0000	(	15)
0.0000	0.0000	0.0000	(	9)
0.0000	0.0000	0.0000	(	14)
0.0000	0.0000	0.0000	(	20)
0.0000	0.0000	0.0000	(	22)
0.0000	0.0000	0.0000	(	10)
0.0000	0.0000	0.0000	(	2)
0.0000	0.0000	0.0000	(	15)
0.4333	0.7506	0.5633	(	3)
0.0000	0.0000	0.0000	(	20)
0.0000	0.0000	0.0000	(	17)
0.8308	0.6674	0.4454	(	26)
6.6000	1.8385	3.3800	(	2)
2.1950	1.3793	1.9026	(	20)
8.5000	3.6495	13.3187	(	16)
2.3200	2.1395	4.5775	(	20)
2.5976	1.5063	2.2688	(	17)
3.2294	2.6596	7.0737	(	34)
0.6000	0.8667	0.7511	(	19)
2.8529	2.3738	5.6351	(	17)
9.4500	2.0517	4.2094	(	10)
6.2900	1.4395	2.0721	(	10)
9.2333	3.5529	12.6233	(	3)
2.9000	0.0000	0.0000	(	1)
2.4000	0.0000	0.0000	(	1)
2.6500	3.0406	9.2450	(	2)
0.9000	0.0000	0.0000	(	1)
0.8000	0.0000	0.0000	(	1)
8.0000	0.0000	0.0000	(	1)
3.8643	2.3571	5.5557	(	28)
1.9967	1.5375	2.3638	(	30)
3.0167	1.0320	1.0650	(	18)
15.4077	3.8651	14.9391	(	13)
18.3400	4.5258	20.4830	(	5)
6.3000	0.0000	0.0000	(	1)
0.1667	0.1528	0.0233	(	3)
12.3000	8.0293	64.4700	(	3)
2.4429	1.2934	1.6729	(	7)

Character C63 Outer Floret Tube Gland Density

mean	std dev	variance		n
0.0000	0.0000	0.0000	(	15)
0.0000	0.0000	0.0000	(	9)
0.0000	0.0000	0.0000	(	14)
0.0000	0.0000	0.0000	(	20)
0.0000	0.0000	0.0000	(	22)
0.0000	0.0000	0.0000	(	10)
0.0000	0.0000	0.0000	(	2)
0.0000	0.0000	0.0000	(	15)
0.1667	0.2887	0.0833	(	3)
0.0000	0.0000	0.0000	(	20)
0.0000	0.0000	0.0000	(	17)
0.6808	0.7037	0.4952	(	26)
40.4500	10.9602	120.1250	(	2)
27.6900	8.9347	79.8294	(	20)
82.5063	26.5483	704.8113	(	16)
36.4950	29.2607	856.1879	(	20)
29.4000	14.6030	213.2475	(	17)
72.3559	24.9233	621.1692	(	34)
5.2842	5.4603	29.8147	(	19)
12.6176	10.6387	113.1815	(	17)
1.1900	0.5322	0.2832	(	10)
4.7400	1.2367	1.5293	(	10)
25.8667	14.5480	211.6433	(	3)
6.8000	0.0000	0.0000	(	1)
21.6000	0.0000	0.0000	(	1)
35.5500	39.6687	1573.6049	(	2)
12.1000	0.0000	0.0000	(	1)
15.7000	0.0000	0.0000	(	1)
29.8000	0.0000	0.0000	(	1)
28.4000	19.2935	372.2385	(	28)
12.4867	8.5796	73.6095	(	30)
32.1889	5.9993	35.9916	(	18)
23.3692	5.2368	27.4240	(	13)
21.9600	6.7010	44.9030	(	5)
28.2000	0.0000	0.0000	(	1)
48.1000	19.5354	381.6300	(	3)
55.7000	5.4580	29.7900	(	3)
56.1429	8.2976	68.8495	(	7)

APPENDIX 3.

Means, standard deviations, and variances of each character, of the seven species and hybrid groups at each of the 21 populations, A to U, in central Scotland

The species and their hybrids were coded as:

Spp. 1. non-radiate _S_. _vulgaris_.

2. radiate _S_. _vulgaris_.

3. short-rayed _S_. _vulgaris_.

4. _S_. _squalidus_.

5. _S_. x _subnebrodenesis_.

6. _S_. _viscosus_.

7. _S_. _sylvaticus_.

Character C02 Plant Height

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	386.3636	149.7560	22426.8545	(11)
	B.	345.1000	57.6993	3329.2111	(10)
	C.	336.6000	84.8190	7194.2667	(10)
	D.	330.8000	136.7738	18707.0667	(10)
	E.	154.8947	25.7938	665.3216	(19)
	F.	170.0000	42.6562	1819.5556	(10)
	G.	323.0000	172.5341	29768.0000	(2)
	H.	177.6000	44.5177	1981.8222	(10)
	I.	181.2500	47.2450	2232.0921	(20)
	J.	207.5000	55.3634	3065.1053	(20)
	K.	333.4000	90.6387	8215.3778	(10)
	L.	384.0000	167.2961	27988.0000	(6)
	M.	268.5000	31.7726	1009.5000	(6)
	N.	245.3000	28.5935	817.5895	(20)
	O.	152.0000	40.1713	1613.7333	(16)
	P.	150.0000	54.3364	2952.4444	(10)
	Q.	262.4000	30.0488	902.9333	(10)
	R.	282.7692	48.5972	2361.6923	(13)
	S.	308.5556	90.6507	8217.5556	(18)
	T.	236.4000	59.1371	3497.2000	(20)
	U.	232.4000	43.8315	1921.2000	(20)
2.	M.	328.2000	93.6041	8761.7333	(10)
	N.	207.4211	26.6027	707.7018	(19)
	O.	142.1765	29.6611	879.7794	(17)
	Q.	248.0000	40.3678	1629.5556	(10)
	R.	168.0000	0.0000	0.0000	(1)
	T.	237.7000	61.4724	3778.8526	(20)
	U.	203.7000	32.2329	1038.9579	(20)
3.	N.	238.0000	66.4680	4418.0000	(2)
	Q.	167.0000	0.0000	0.0000	(1)
4.	K.	234.6667	50.6195	2562.3333	(3)
	L.	212.0000	68.9710	4757.0000	(9)
	M.	362.2000	57.4865	3304.7000	(5)
	N.	301.1765	90.2180	8139.2794	(17)
	O.	293.1000	97.4696	9500.3222	(10)
	P.	325.5000	51.7020	2673.1000	(6)
	T.	354.0000	85.3976	7292.7500	(9)
	U.	247.3333	39.5769	1566.3333	(3)
5.	L.	196.4000	40.2405	1619.3000	(5)
	M.	445.3000	124.5249	15506.4556	(10)
	O.	306.0000	184.2987	33966.0000	(4)
6.	G.	489.0000	45.6892	2087.5000	(5)
	H.	362.6667	85.8856	7376.3333	(3)
	K.	571.0000	186.6762	34848.0000	(2)
	L.	364.8889	127.7883	16329.8611	(9)
	M.	426.3000	111.9733	12538.0111	(10)
	O.	464.6667	131.7279	17352.2500	(9)
	Q.	450.6667	151.9114	23077.0667	(6)
	R.	241.1250	76.3740	5832.9821	(8)
	T.	308.8000	68.7946	4732.7000	(5)
7.	R.	442.8235	153.1969	23469.2794	(17)

Character C03 Inflorescence Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	21.0000	4.6260	21.4000	(11)
	B.	20.6000	3.6878	13.6000	(10)
	C.	21.6000	4.4020	19.3778	(10)
	D.	22.1000	4.7011	22.1000	(10)
	E.	18.0000	4.4597	19.8889	(19)
	F.	17.7000	2.9458	8.6778	(10)
	G.	18.0000	2.8284	8.0000	(2)
	H.	22.8000	6.8118	46.4000	(10)
	I.	16.0000	7.6089	57.8947	(20)
	J.	18.3000	4.0144	16.1158	(20)
	K.	24.2000	3.2931	10.8444	(10)
	L.	25.5000	6.6858	44.7000	(6)
	M.	23.3333	5.5737	31.0667	(6)
	N.	25.3500	4.9976	24.9763	(20)
	O.	16.1250	4.8287	23.3167	(16)
	P.	14.4000	3.0258	9.1556	(10)
	Q.	27.4000	11.0272	121.6000	(10)
	R.	29.7692	6.1935	38.3590	(13)
	S.	21.1111	5.6765	32.2222	(18)
	T.	20.2000	4.9588	24.5895	(20)
	U.	21.6500	6.9908	48.8711	(20)
2.	M.	23.7000	5.2715	27.7889	(10)
	N.	22.0526	2.9340	8.6082	(19)
	O.	15.1765	3.2449	10.5294	(17)
	Q.	22.8000	2.8983	8.4000	(10)
	R.	18.0000	0.0000	0.0000	(1)
	T.	17.9000	4.9086	24.0947	(20)
	U.	17.1500	3.9239	15.3974	(20)
3.	N.	24.5000	0.7071	0.5000	(2)
	Q.	28.0000	0.0000	0.0000	(1)
4.	K.	27.0000	6.0000	36.0000	(3)
	L.	29.6667	7.1414	51.0000	(9)
	M.	29.2000	4.2661	18.2000	(5)
	N.	27.8235	5.9711	35.6544	(17)
	O.	32.5000	19.7498	390.0556	(10)
	P.	34.3333	8.3347	69.4667	(6)
	T.	37.5556	6.2871	39.5278	(9)
	U.	26.6667	5.7735	33.3333	(3)
5.	L.	26.6000	5.5045	30.3000	(5)
	M.	36.0000	10.2632	105.3333	(10)
	O.	26.7500	4.7871	22.9167	(4)
6.	G.	27.2000	5.7619	33.2000	(5)
	H.	41.6667	5.1316	26.3333	(3)
	K.	26.5000	10.6066	112.5000	(2)
	L.	30.3333	8.9582	80.2500	(9)
	M.	30.5000	8.2630	68.2778	(10)
	O.	34.7778	11.8192	139.6944	(9)
	Q.	37.6667	10.0133	100.2667	(6)
	R.	36.8750	6.7915	46.1250	(8)
	T.	32.2000	9.4974	90.2000	(5)
7.	R.	20.7059	7.2952	53.2206	(17)

Character C04 Number Of Internodes

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	20.2727	2.8316	8.0182	(11)
	B.	21.4000	1.4298	2.0444	(10)
	C.	21.1000	1.9120	3.6556	(10)
	D.	18.3000	2.3594	5.5667	(10)
	E.	12.2105	2.4170	5.8421	(19)
	F.	21.0000	2.7487	7.5556	(10)
	G.	23.5000	3.5355	12.5000	(2)
	H.	18.9000	2.4698	6.1000	(10)
	I.	20.3000	2.6378	6.9579	(20)
	J.	21.3500	2.2308	4.9763	(20)
	K.	15.2000	2.8597	8.1778	(10)
	L.	14.3333	2.1602	4.6667	(6)
	M.	18.3333	2.6583	7.0667	(6)
	N.	17.7000	1.6255	2.6421	(20)
	O.	19.7500	2.5166	6.3333	(16)
	P.	19.6000	3.2728	10.7111	(10)
	Q.	18.6000	2.0111	4.0444	(10)
	R.	18.0769	2.1780	4.7436	(13)
	S.	21.3889	2.1731	4.7222	(18)
	T.	20.6500	1.6631	2.7658	(20)
	U.	21.1000	2.0235	4.0947	(20)
2.	M.	17.5000	2.5927	6.7222	(10)
	N.	17.3684	1.9779	3.9123	(19)
	O.	19.7059	2.0238	4.0956	(17)
	Q.	18.3000	2.0028	4.0111	(10)
	R.	16.0000	0.0000	0.0000	(1)
	T.	21.2500	1.8317	3.3553	(20)
	U.	20.3000	2.4516	6.0105	(20)
3.	N.	22.0000	5.6569	32.0000	(2)
	Q.	18.0000	0.0000	0.0000	(1)
4.	K.				(7)
	L.	35.2222	5.4493	29.6944	(9)
	M.	20.6000	2.7019	7.3000	(5)
	N.	29.0000	8.0390	64.6250	(17)
	O.	42.6000	7.2449	52.4889	(10)
	P.	25.5000	3.7283	13.9000	(6)
	T.	40.2222	3.8006	14.4444	(9)
	U.	31.6667	2.5166	6.3333	(3)
5.	L.	24.0000	7.1764	51.5000	(5)
	M.	22.0000	2.5820	6.6667	(10)
	O.	17.5000	2.0817	4.3333	(4)
6.	G.	33.4000	3.3615	11.3000	(5)
	H.	31.0000	8.0000	64.0000	(3)
	K.	40.5000	3.5355	12.5000	(2)
	L.	32.4444	6.4053	41.0278	(9)
	M.	34.3000	5.9451	35.3444	(10)
	O.	30.3333	6.2249	38.7500	(9)
	Q.	24.6667	6.8313	46.6667	(6)
	R.	19.1250	3.3139	10.9821	(8)
	T.	37.8000	4.0249	16.2000	(5)
7.	R.	40.1765	4.6802	21.9044	(17)

Character CO5 Basal Stem Diameter

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	3.7000	0.7912	0.6260	(11)
	B.	5.2800	1.6096	2.5907	(10)
	C.	5.2200	1.3685	1.8729	(10)
	D.	4.2400	1.1510	1.3249	(10)
	E.	3.6316	0.4900	0.2401	(19)
	F.	3.5100	0.5626	0.3166	(10)
	G.	5.0000	0.1414	0.0200	(2)
	H.	4.6600	0.8181	0.6693	(10)
	I.	3.5150	0.8586	0.7371	(20)
	J.	3.7650	0.6450	0.4161	(20)
	K.	4.7700	1.4499	2.1023	(10)
	L.	5.6333	1.6170	2.6147	(6)
	M.	5.6833	1.3467	1.8137	(6)
	N.	5.4950	1.3567	1.8405	(20)
	O.	3.6187	0.8635	0.7456	(16)
	P.	3.8700	0.6881	0.4734	(10)
	Q.	4.7800	1.4748	2.1751	(10)
	R.	6.0846	0.9299	0.8647	(13)
	S.	5.3556	0.8638	0.7461	(18)
	T.	4.2800	1.0451	1.0922	(20)
	U.	4.2750	0.8372	0.7009	(20)
2.	M.	5.8300	1.4361	2.0623	(10)
	N.	5.2526	1.1909	1.4182	(19)
	O.	3.9353	0.9387	0.8812	(17)
	Q.	6.0200	1.2470	1.5551	(10)
	R.	6.9000	0.0000	0.0000	(1)
	T.	3.8100	0.8447	0.7136	(20)
	U.	3.8500	0.9282	0.8616	(20)
3.	N.	5.9000	0.4243	0.1800	(2)
	Q.	6.1000	0.0000	0.0000	(1)
4.	K.	5.8333	1.1015	1.2133	(3)
	L.	4.0444	1.0199	1.0403	(9)
	M.	6.3400	1.8474	3.4130	(5)
	N.	6.6588	1.1281	1.2726	(17)
	O.	6.5200	1.5237	2.3218	(10)
	P.	7.6167	1.8038	3.2537	(6)
	T.	7.4222	0.9458	0.8944	(9)
	U.	5.3667	0.6429	0.4133	(3)
5.	L.	3.5000	1.1576	1.3400	(5)
	M.	5.3100	1.3527	1.8299	(10)
	O.	5.6250	3.0237	9.1425	(4)
6.	G.	6.0800	0.7596	0.5770	(5)
	H.	6.4667	2.7209	7.4033	(3)
	K.	8.4500	2.0506	4.2050	(2)
	L.	5.8222	1.4472	2.0944	(9)
	M.	4.6800	0.6070	0.3684	(10)
	O.	6.5889	2.2195	4.9261	(9)
	Q.	6.2833	1.7589	3.0937	(6)
	R.	5.5250	1.5526	2.4107	(8)
	T.	7.7000	1.3096	1.7150	(5)
7.	R.	7.8765	1.6821	2.8294	(17)

Character C06 Number Of Leaves

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	48.1818	22.3106	497.7636	(11)
	B.	81.7000	40.9310	1675.3444	(10)
	C.	89.3000	52.6879	2776.0111	(10)
	D.	54.1000	27.6383	763.8778	(10)
	E.	33.6316	13.1749	173.5789	(19)
	F.	54.5000	15.1895	230.7222	(10)
	G.	54.5000	6.3640	40.5000	(2)
	H.	54.5000	18.2589	333.3889	(10)
	I.	41.7500	24.9312	621.5658	(20)
	J.	51.4000	16.4201	269.6211	(20)
	K.	57.5000	30.4713	928.5000	(10)
	L.	80.5000	63.7613	4065.5000	(6)
	M.	87.3333	38.3336	1469.4667	(6)
	N.	85.7500	35.9428	1291.8816	(20)
	O.	46.1875	17.1822	295.2292	(16)
	P.	44.4000	10.6165	112.7111	(10)
	Q.	75.3000	45.1296	2036.6778	(10)
	R.	96.0000	26.1024	681.3333	(13)
	S.	66.0000	20.1582	406.3529	(18)
	T.	56.2500	26.0483	678.5132	(20)
	U.	66.5000	20.9071	437.1053	(20)
2.	M.	90.7000	47.8099	2285.7889	(10)
	N.	79.8947	33.6037	1129.2105	(19)
	O.	50.7059	27.0203	730.0956	(17)
	Q.	81.0000	24.7656	613.3333	(10)
	R.	72.0000	0.0000	0.0000	(1)
	T.	40.0500	13.8772	192.5763	(20)
	U.	56.1000	24.3913	594.9368	(20)
3.	N.	96.0000	9.8995	98.0000	(2)
	Q.	104.0000	0.0000	0.0000	(1)
4.	K.	67.3333	21.5019	462.3333	(3)
	L.	52.7778	20.7411	430.1944	(9)
	M.	89.0000	58.2194	3389.5000	(5)
	N.	117.3529	29.8683	892.1176	(17)
	O.	155.2000	73.5207	5405.2889	(10)
	P.	135.0000	72.6140	5272.8000	(6)
	T.	178.3333	81.7313	6680.0000	(9)
	U.	73.6667	16.5630	274.3333	(3)
5.	L.	42.2000	21.5221	463.2000	(5)
	M.	68.0000	41.5826	1729.1111	(10)
	O.	72.7500	44.4475	1975.5833	(4)
6.	G.	82.8000	9.5499	91.2000	(5)
	H.	132.0000	96.1301	9241.0000	(3)
	K.	310.0000	318.1981	101250.0000	(2)
	L.	77.0000	35.1105	1232.7500	(9)
	M.	69.6000	11.1176	123.6000	(10)
	O.	177.2222	103.7494	10763.9444	(9)
	Q.	92.1667	46.3397	2147.3667	(6)
	R.	63.6250	22.1226	489.4107	(8)
	T.	144.8000	37.3791	1397.2000	(5)
7.	R.	134.5882	85.2878	7274.0074	(17)

Character C07 Propn Laterals With Capitula

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	0.4082	0.1805	0.0326	(11)
	B.	0.5750	0.2472	0.0611	(10)
	C.	0.6100	0.2367	0.0560	(10)
	D.	0.5270	0.2177	0.0474	(10)
	E.	0.6595	0.1733	0.0300	(19)
	F.	0.4990	0.2059	0.0424	(10)
	G.	0.5200	0.4101	0.1682	(2)
	H.	0.4790	0.1507	0.0227	(10)
	I.	0.3830	0.1799	0.0324	(20)
	J.	0.4255	0.1174	0.0138	(20)
	K.	0.8380	0.1696	0.0288	(10)
	L.	0.8017	0.2422	0.0587	(6)
	M.	0.8350	0.0944	0.0089	(6)
	N.	0.8330	0.1596	0.0255	(20)
	O.	0.4250	0.1983	0.0393	(16)
	P.	0.4540	0.2123	0.0451	(10)
	Q.	0.5930	0.1808	0.0327	(10)
	R.	0.8685	0.1100	0.0121	(13)
	S.	0.6550	0.1346	0.0181	(18)
	T.	0.5370	0.2206	0.0487	(20)
	U.	0.5240	0.1681	0.0283	(20)
2.	M.	0.7290	0.2526	0.0638	(10)
	N.	0.8142	0.1356	0.0184	(19)
	O.	0.4076	0.2198	0.0483	(17)
	Q.	0.8020	0.2025	0.0410	(10)
	R.	0.6200	0.0000	0.0000	(1)
	T.	0.3435	0.1506	0.0227	(20)
	U.	0.4180	0.1288	0.0166	(20)
3.	N.	0.9150	0.0354	0.0013	(2)
	Q.	0.8900	0.0000	0.0000	(1)
4.	K.	0.3200	0.0400	0.0016	(3)
	L.	0.1422	0.0753	0.0057	(9)
	M.	0.5820	0.2535	0.0643	(5)
	N.	0.4029	0.2100	0.0441	(17)
	O.	0.1850	0.1287	0.0166	(10)
	P.	0.4317	0.2842	0.0808	(6)
	T.	0.2244	0.1164	0.0136	(9)
	U.	0.1900	0.0265	0.0007	(3)
5.	L.	0.2600	0.0485	0.0024	(5)
	M.	0.4900	0.1791	0.0321	(10)
	O.	0.4950	0.1708	0.0292	(4)
6.	G.	0.2420	0.0776	0.0060	(5)
	H.	0.4333	0.1553	0.0241	(3)
	K.	0.5000	0.4808	0.2312	(2)
	L.	0.2711	0.1121	0.0126	(9)
	M.	0.2740	0.0499	0.0025	(10)
	O.	0.6189	0.1837	0.0337	(9)
	Q.	0.4600	0.1906	0.0363	(6)
	R.	0.4987	0.1931	0.0373	(8)
	T.	0.4320	0.1076	0.0116	(5)
7.	R.	0.5100	0.1585	0.0251	(17)

Character C08 Longest Leaf Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	81.4545	15.2798	233.4727	(11)
	B.	79.9000	23.2783	541.8778	(10)
	C.	77.3000	15.5924	243.1222	(10)
	D.	77.1000	17.9410	321.8778	(10)
	E.	95.3684	14.0918	198.5789	(19)
	F.	87.9000	15.4017	237.2111	(10)
	G.	114.5000	9.1924	84.5000	(2)
	H.	79.0000	9.6032	92.2222	(10)
	I.	83.2500	18.4245	339.4605	(20)
	J.	89.5500	17.2915	298.9974	(20)
	K.	82.3000	27.1950	739.5667	(10)
	L.	104.8333	21.6002	466.5667	(6)
	M.	89.8333	16.6903	278.5667	(6)
	N.	107.0000	14.4768	209.5789	(20)
	O.	74.8125	22.5838	510.0292	(16)
	P.	82.3000	8.8450	78.2333	(10)
	Q.	83.2000	22.2501	495.0667	(10)
	R.	105.3077	13.5609	183.8974	(13)
	S.	103.6111	14.8210	219.6634	(18)
	T.	101.2500	18.2897	334.5132	(20)
	U.	104.1000	21.5941	466.3053	(20)
2.	M.	85.2000	19.9989	399.9556	(10)
	N.	88.1053	15.8741	251.9883	(19)
	O.	72.7059	16.7510	280.5956	(17)
	Q.	86.5000	15.2698	233.1667	(10)
	R.	86.0000	0.0000	0.0000	(1)
	T.	90.0000	18.4191	339.2632	(20)
	U.	85.1500	14.7015	216.1342	(20)
3.	N.	102.0000	24.0416	578.0000	(2)
	Q.	86.0000	0.0000	0.0000	(1)
4.	K.	95.0000	9.0000	81.0000	(3)
	L.	68.3333	22.2486	495.0000	(9)
	M.	114.0000	13.4164	180.0000	(5)
	N.	126.4118	19.1574	367.0074	(17)
	O.	98.1000	24.5604	603.2111	(10)
	P.	109.3333	19.8863	395.4667	(6)
	T.	123.2222	29.6048	876.4444	(9)
	U.	102.3333	33.7095	1136.3333	(3)
5.	L.	51.0000	10.2713	105.5000	(5)
	M.	98.8000	31.4459	988.8444	(10)
	O.	91.5000	45.6691	2085.6667	(4)
6.	G.	140.4000	9.0719	82.3000	(5)
	H.	93.0000	37.4032	1399.0000	(3)
	K.	126.5000	26.1630	684.5000	(2)
	L.	86.3333	17.8466	318.5000	(9)
	M.	80.0000	14.6211	213.7778	(10)
	O.	111.7778	26.8690	721.9444	(9)
	Q.	113.1667	27.7879	772.1667	(6)
	R.	73.6250	29.4421	866.8393	(8)
	T.	82.6000	6.0249	36.3000	(5)
7.	R.	98.0000	23.4494	549.8750	(17)

Character C09 Midleaf Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	72.0000	12.6491	160.0000	(11)
	B.	71.1000	18.9470	358.9889	(10)
	C.	68.6000	13.6072	185.1556	(10)
	D.	72.4000	16.0361	257.1556	(10)
	E.	87.5789	11.4519	131.1462	(19)
	F.	70.7000	11.0660	122.4556	(10)
	G.	99.0000	12.7279	162.0000	(2)
	H.	68.0000	9.8658	97.3333	(10)
	I.	73.7000	15.7417	247.8000	(20)
	J.	77.6500	16.4358	270.1342	(20)
	K.	77.8000	24.2798	589.5111	(10)
	L.	91.6667	20.4222	417.0667	(6)
	M.	75.0000	10.1980	104.0000	(6)
	N.	83.4500	10.7922	116.4711	(20)
	O.	69.1875	20.6146	424.9625	(16)
	P.	67.5000	8.4623	71.6111	(10)
	Q.	63.3000	19.7318	389.3444	(10)
	R.	82.3846	13.3012	176.9231	(13)
	S.	91.0000	14.3486	205.8824	(18)
	T.	86.6500	16.0731	258.3447	(20)
	U.	86.8500	18.5537	344.2395	(20)
2.	M.	69.3000	15.9586	254.6778	(10)
	N.	74.5789	13.3638	178.5906	(19)
	O.	61.7647	14.2720	203.6912	(17)
	Q.	74.8000	13.1217	172.1778	(10)
	R.	65.0000	0.0000	0.0000	(1)
	T.	76.5000	18.9778	360.1579	(20)
	U.	73.8000	14.6812	215.5368	(20)
3.	N.	74.5000	14.8492	220.5000	(2)
	Q.	65.0000	0.0000	0.0000	(1)
4.	K.	87.6667	4.5092	20.3333	(3)
	L.	59.1111	16.9591	287.6111	(9)
	M.	94.6000	17.3147	299.8000	(5)
	N.	111.4706	15.8237	250.3897	(17)
	O.	89.2000	21.3791	457.0667	(10)
	P.	82.1667	20.0541	402.1667	(6)
	T.	108.6667	25.0450	627.2500	(9)
	U.	87.6667	35.0048	1225.3333	(3)
5.	L.	43.8000	5.6303	31.7000	(5)
	M.	83.2000	24.1376	582.6222	(10)
	O.	82.7500	45.5146	2071.5833	(4)
6.	G.	125.0000	6.9642	48.5000	(5)
	H.	59.3333	16.9214	286.3333	(3)
	K.	94.5000	7.7782	60.5000	(2)
	L.	65.8889	15.4065	237.3611	(9)
	M.	57.8000	7.5542	57.0667	(10)
	O.	81.6667	12.9711	168.2500	(9)
	Q.	76.3333	19.1903	368.2667	(6)
	R.	58.1250	17.0331	290.1250	(8)
	T.	67.0000	11.5542	133.5000	(5)
7.	R.	80.6471	24.1659	583.9926	(17)

Character C101 Midleaf Total Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	24.7273	5.9513	35.4182	(11)
	B.	28.0000	10.2089	104.2222	(10)
	C.	26.6000	6.1680	38.0444	(10)
	D.	27.7000	7.7467	60.0111	(10)
	E.	38.7368	6.4104	41.0936	(19)
	F.	34.8000	2.9740	8.8444	(10)
	G.	52.0000	8.4853	72.0000	(2)
	H.	33.6000	3.8644	14.9333	(10)
	I.	34.0500	8.5746	73.5237	(20)
	J.	33.1000	7.2250	52.2000	(20)
	K.	39.5000	10.7005	114.5000	(10)
	L.	40.0000	6.6933	44.8000	(6)
	M.	37.3333	2.8752	8.2667	(6)
	N.	45.8000	5.4541	29.7474	(20)
	O.	31.3750	8.4764	71.8500	(16)
	P.	28.7000	2.8304	8.0111	(10)
	Q.	33.7000	12.9448	167.5667	(10)
	R.	38.4615	8.4520	71.4359	(13)
	S.	41.7222	7.6528	58.5654	(18)
	T.	43.8500	12.0319	144.7658	(20)
	U.	42.8000	11.4414	130.9053	(20)
2.	M.	38.8000	10.2176	104.4000	(10)
	N.	41.7895	7.6709	58.8421	(19)
	O.	36.4118	10.0004	100.0074	(17)
	Q.	52.1000	9.6546	93.2111	(10)
	R.	35.0000	0.0000	0.0000	(1)
	T.	43.9500	7.2727	52.8921	(20)
	U.	38.5000	7.5149	56.4737	(20)
3.	N.	44.5000	2.1213	4.5000	(2)
	Q.	27.0000	0.0000	0.0000	(1)
4.	K.	55.6667	15.6950	246.3333	(3)
	L.	37.7778	11.9455	142.6944	(9)
	M.	62.0000	7.5166	56.5000	(5)
	N.	65.5882	13.7662	189.5074	(17)
	O.	52.8000	18.6655	348.4000	(10)
	P.	60.5000	14.3213	205.1000	(6)
	T.	66.1111	14.3827	206.8611	(9)
	U.	45.6667	8.7369	76.3333	(3)
5.	L.	23.0000	3.1623	10.0000	(5)
	M.	41.2000	12.0996	146.4000	(10)
	O.	45.2500	24.5951	604.9167	(4)
6.	G.	77.2000	6.6106	43.7000	(5)
	H.	39.3333	9.7125	94.3333	(3)
	K.	57.5000	16.2635	264.5000	(2)
	L.	41.7778	8.8991	79.1944	(9)
	M.	38.2000	5.4934	30.1778	(10)
	O.	53.6667	9.3005	86.5000	(9)
	Q.	50.5000	14.3631	206.3000	(6)
	R.	38.6250	11.8676	140.8393	(8)
	T.	44.8000	7.9183	62.7000	(5)
7.	R.	39.2353	15.5464	241.6912	(17)

Character C121 MLF Mean Base To Max Width Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	42.4545	7.6074	57.8727	(11)
	B.	44.0000	12.5344	157.1111	(10)
	C.	40.0000	8.7560	76.6667	(10)
	D.	44.4000	8.8719	78.7111	(10)
	E.	53.3684	7.3953	54.6901	(19)
	F.	38.1000	10.1154	102.3222	(10)
	G.	63.0000	11.3137	128.0000	(2)
	H.	42.7000	7.1188	50.6778	(10)
	I.	47.5500	8.1659	66.6816	(20)
	J.	48.8000	8.1924	67.1158	(20)
	K.	48.9000	18.5918	345.6556	(10)
	L.	49.8333	4.6224	21.3667	(6)
	M.	47.5000	2.5884	6.7000	(6)
	N.	49.5500	8.4634	71.6289	(20)
	O.	46.1875	14.7703	218.1625	(16)
	P.	45.5000	9.1318	83.3889	(10)
	Q.	32.4000	11.3549	128.9333	(10)
	R.	49.9231	9.7763	95.5769	(13)
	S.	58.5000	10.1184	102.3824	(18)
	T.	54.5000	12.7919	163.6316	(20)
	U.	56.8500	12.4616	155.2921	(20)
2.	M.	42.3000	11.0257	121.5667	(10)
	N.	42.0526	9.1620	83.9415	(19)
	O.	41.4706	9.0008	81.0147	(17)
	Q.	49.1000	8.7617	76.7667	(10)
	R.	42.0000	0.0000	0.0000	(1)
	T.	51.7000	15.3489	235.5895	(20)
	U.	45.7500	11.5798	134.0921	(20)
3.	N.	44.0000	12.7279	162.0000	(2)
	Q.	44.0000	0.0000	0.0000	(1)
4.	K.	47.6667	14.5717	212.3333	(3)
	L.	30.4444	9.7225	94.5278	(9)
	M.	66.2000	13.7004	187.7000	(5)
	N.	63.2353	13.9308	194.0662	(17)
	O.	45.0000	13.5565	183.7778	(10)
	P.	42.8333	15.4067	237.3667	(6)
	T.	58.0000	19.9625	398.5000	(9)
	U.	58.3333	16.9214	286.3333	(3)
5.	L.	26.0000	4.7434	22.5000	(5)
	M.	42.3000	10.3928	108.0111	(10)
	O.	40.5000	19.3993	376.3333	(4)
6.	G.	84.6000	8.0808	65.3000	(5)
	H.	36.6667	4.9329	24.3333	(3)
	K.	60.5000	3.5355	12.5000	(2)
	L.	43.1111	11.5806	134.1111	(9)
	M.	42.0000	5.5976	31.3333	(10)
	O.	56.0000	11.5974	134.5000	(9)
	Q.	53.0000	14.1563	200.4000	(6)
	R.	39.0000	8.2635	68.2857	(8)
	T.	47.8000	8.1976	67.2000	(5)
7.	R.	44.1765	16.5689	274.5294	(17)

Character C14 MLF Auricle Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	15.5455	4.2039	17.6727	(11)
	B.	16.1000	5.4863	30.1000	(10)
	C.	15.3000	3.7727	14.2333	(10)
	D.	14.0000	4.4472	19.7778	(10)
	E.	16.2105	4.6258	21.3977	(19)
	F.	13.1000	1.4491	2.1000	(10)
	G.	11.5000	4.9497	24.5000	(2)
	H.	12.6000	1.6465	2.7111	(10)
	I.	11.5500	4.3344	18.7868	(20)
	J.	11.5500	4.3465	18.8921	(20)
	K.	17.4000	7.1212	50.7111	(10)
	L.	21.0000	4.4272	19.6000	(6)
	M.	14.3333	2.4221	5.8667	(6)
	N.	18.0500	6.6211	43.8395	(20)
	O.	12.0625	4.0244	16.1958	(16)
	P.	11.5000	1.7795	3.1667	(10)
	Q.	17.1000	6.8386	46.7667	(10)
	R.	18.2308	5.3096	28.1923	(13)
	S.	17.7778	2.9216	8.5359	(18)
	T.	13.5500	3.8454	14.7868	(20)
	U.	15.3500	7.3361	53.8184	(20)
2.	M.	16.9000	3.1429	9.8778	(10)
	N.	14.0526	6.2581	39.1637	(19)
	O.	12.9412	4.4225	19.5588	(17)
	Q.	17.2000	2.6162	6.8444	(10)
	R.	19.0000	0.0000	0.0000	(1)
	T.	12.6500	3.1834	10.1342	(20)
	U.	13.2000	3.2053	10.2737	(20)
3.	N.	17.0000	1.4142	2.0000	(2)
	Q.	16.0000	0.0000	0.0000	(1)
4.	K.	9.0000	6.0000	36.0000	(3)
	L.	5.6667	1.4142	2.0000	(9)
	M.	18.2000	3.8341	14.7000	(5)
	N.	10.7647	3.8654	14.9412	(17)
	O.	8.3000	5.2715	27.7889	(10)
	P.	10.6667	2.8048	7.8667	(6)
	T.	6.6667	2.3979	5.7500	(9)
	U.	5.0000	1.0000	1.0000	(3)
5.	L.	9.4000	3.4351	11.8000	(5)
	M.	16.5000	4.8591	23.6111	(10)
	O.	18.7500	9.9121	98.2500	(4)
6.	G.	19.6000	2.1909	4.8000	(5)
	H.	8.6667	0.5774	0.3333	(3)
	K.	13.5000	3.5355	12.5000	(2)
	L.	10.2222	3.8333	14.6944	(9)
	M.	9.4000	2.2211	4.9333	(10)
	O.	14.6667	3.7749	14.2500	(9)
	Q.	13.8333	4.0208	16.1667	(6)
	R.	11.1250	5.8172	33.8393	(8)
	T.	11.0000	2.0000	4.0000	(5)
7.	R.	12.8824	4.4424	19.7353	(17)

Character C15 MLF Auricle Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	17.0909	4.1099	16.8909	(11)
	B.	21.5000	8.5926	73.8333	(10)
	C.	20.8000	5.7310	32.8444	(10)
	D.	17.3000	4.5959	21.1222	(10)
	E.	22.6842	6.0097	36.1170	(19)
	F.	17.2000	3.3599	11.2889	(10)
	G.	13.5000	3.5355	12.5000	(2)
	H.	19.4000	2.9136	8.4889	(10)
	I.	16.9000	5.7847	33.4632	(20)
	J.	16.5000	4.7072	22.1579	(20)
	K.	20.0000	6.9921	48.8889	(10)
	L.	24.0000	5.6214	31.6000	(6)
	M.	19.6667	2.4221	5.8667	(6)
	N.	23.7000	6.3503	40.3263	(20)
	O.	14.9375	4.2185	17.7958	(16)
	P.	13.7000	2.3118	5.3444	(10)
	Q.	20.1000	7.5785	57.4333	(10)
	R.	22.5385	7.0901	50.2692	(13)
	S.	22.3333	3.4471	11.8824	(18)
	T.	20.3000	5.9125	34.9579	(20)
	U.	21.5500	8.6904	75.5237	(20)
2.	M.	24.5000	6.7041	44.9444	(10)
	N.	19.1053	6.7733	45.8772	(19)
	O.	16.8235	6.1769	38.1544	(17)
	Q.	31.0000	3.7118	13.7778	(10)
	R.	23.0000	0.0000	0.0000	(1)
	T.	15.2500	4.8761	23.7763	(20)
	U.	17.6000	4.2352	17.9368	(20)
3.	N.	23.5000	0.7071	0.5000	(2)
	Q.	20.0000	0.0000	0.0000	(1)
4.	K.	11.0000	6.2450	39.0000	(3)
	L.	8.8889	1.4530	2.1111	(9)
	M.	25.0000	8.4261	71.0000	(5)
	N.	14.7059	5.0592	25.5956	(17)
	O.	10.8000	4.7329	22.4000	(10)
	P.	17.3333	3.9328	15.4667	(6)
	T.	13.3333	4.3589	19.0000	(9)
	U.	11.0000	1.0000	1.0000	(3)
5.	L.	10.2000	2.9496	8.7000	(5)
	M.	17.7000	6.2013	38.4556	(10)
	O.	25.2500	18.5180	342.9167	(4)
6.	G.	27.0000	4.6368	21.5000	(5)
	H.	14.3333	4.1633	17.3333	(3)
	K.	18.0000	8.4853	72.0000	(2)
	L.	14.2222	5.2387	27.4444	(9)
	M.	13.0000	2.4037	5.7778	(10)
	O.	19.1111	6.7165	45.1111	(9)
	Q.	19.1667	7.6529	58.5667	(6)
	R.	18.2500	11.0421	121.9286	(8)
	T.	15.0000	3.1623	10.0000	(5)
7.	R.	15.8235	7.6831	59.0294	(17)

Character C17 MLF Apical Lobe Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	14.8182	2.4827	6.1636	(11)
	B.	14.6000	4.0879	16.7111	(10)
	C.	13.5000	2.9155	8.5000	(10)
	D.	15.0000	3.9721	15.7778	(10)
	E.	19.3684	3.8037	14.4678	(19)
	F.	17.0000	2.1602	4.6667	(10)
	G.	22.5000	2.1213	4.5000	(2)
	H.	15.5000	2.1731	4.7222	(10)
	I.	19.7500	3.9454	15.5658	(20)
	J.	19.9500	4.3465	18.8921	(20)
	K.	20.0000	7.7316	59.7778	(10)
	L.	18.8333	5.8109	33.7667	(6)
	M.	16.3333	3.5024	12.2667	(6)
	N.	22.6500	3.4378	11.8184	(20)
	O.	16.0000	5.3666	28.8000	(16)
	P.	17.0000	1.7638	3.1111	(10)
	Q.	17.9000	6.1545	37.8778	(10)
	R.	21.7692	4.4936	20.1923	(13)
	S.	22.0000	5.6672	32.1176	(18)
	T.	19.7000	5.6017	31.3789	(20)
	U.	21.5500	5.0207	25.2079	(20)
2.	M.	19.9000	4.6536	21.6556	(10)
	N.	23.0000	4.2817	18.3333	(19)
	O.	18.9412	4.5479	20.6838	(17)
	Q.	24.0000	3.8006	14.4444	(10)
	R.	18.0000	0.0000	0.0000	(1)
	T.	21.7000	4.0144	16.1158	(20)
	U.	18.2500	3.5374	12.5132	(20)
3.	N.	20.0000	2.8284	8.0000	(2)
	Q.	18.0000	0.0000	0.0000	(1)
4.	K.	35.0000	6.0828	37.0000	(3)
	L.	30.6667	8.0467	64.7500	(9)
	M.	35.0000	5.7009	32.5000	(5)
	N.	39.8824	7.7289	59.7353	(17)
	O.	36.7000	8.9325	79.7889	(10)
	P.	38.5000	8.3367	69.5000	(6)
	T.	45.5556	15.1584	229.7778	(9)
	U.	38.0000	5.2915	28.0000	(3)
5.	L.	13.2000	2.7749	7.7000	(5)
	M.	24.4000	6.9314	48.0444	(10)
	O.	25.0000	14.7196	216.6667	(4)
6.	G.	47.6000	3.9115	15.3000	(5)
	H.	22.6667	5.5076	30.3333	(3)
	K.	32.0000	5.6569	32.0000	(2)
	L.	23.1111	7.0079	49.1111	(9)
	M.	21.1000	5.5267	30.5444	(10)
	O.	30.3333	8.2462	68.0000	(9)
	Q.	28.1667	10.3037	106.1667	(6)
	R.	20.6250	5.8049	33.6964	(8)
	T.	26.2000	4.6043	21.2000	(5)
7.	R.	14.3529	5.9155	34.9926	(17)

Character C18 MLF Apical Lobe Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	10.5455	2.7336	7.4727	(11)
	B.	10.0000	2.3570	5.5556	(10)
	C.	10.2000	3.4577	11.9556	(10)
	D.	10.4000	2.4129	5.8222	(10)
	E.	12.6316	2.8715	8.2456	(19)
	F.	9.6000	2.2706	5.1556	(10)
	G.	10.5000	2.1213	4.5000	(2)
	H.	5.8000	0.7888	0.6222	(10)
	I.	10.1500	1.6944	2.8711	(20)
	J.	10.1500	2.0333	4.1342	(20)
	K.	11.3000	3.4976	12.2333	(10)
	L.	10.3333	1.8619	3.4667	(6)
	M.	8.3333	1.3663	1.8667	(6)
	N.	13.2500	3.3541	11.2500	(20)
	O.	10.3125	4.4230	19.5625	(16)
	P.	9.7000	1.7029	2.9000	(10)
	Q.	8.4000	1.5776	2.4889	(10)
	R.	9.6154	1.8502	3.4231	(13)
	S.	10.4444	1.6169	2.6144	(18)
	T.	8.4500	1.5720	2.4711	(20)
	U.	10.1500	1.6944	2.8711	(20)
2.	M.	9.8000	2.5298	6.4000	(10)
	N.	10.1053	3.4944	12.2105	(19)
	O.	9.0000	2.6693	7.1250	(17)
	Q.	10.0000	1.8856	3.5556	(10)
	R.	5.0000	0.0000	0.0000	(1)
	T.	9.3000	2.4730	6.1158	(20)
	U.	8.7000	1.8946	3.5895	(20)
3.	N.	13.5000	6.3640	40.5000	(2)
	Q.	6.0000	0.0000	0.0000	(1)
4.	K.	11.6667	2.5166	6.3333	(3)
	L.	17.1111	4.9103	24.1111	(9)
	M.	16.2000	0.8367	0.7000	(5)
	N.	12.1176	3.8711	14.9853	(17)
	O.	15.2000	5.4732	29.9556	(10)
	P.	14.6667	2.8048	7.8667	(6)
	T.	18.8889	8.5212	72.6111	(9)
	U.	12.6667	2.5166	6.3333	(3)
5.	L.	7.2000	1.7889	3.2000	(5)
	M.	14.4000	5.1467	26.4889	(10)
	O.	13.2500	6.1305	37.5833	(4)
6.	G.	26.0000	1.8708	3.5000	(5)
	H.	12.6667	4.6188	21.3333	(3)
	K.	18.5000	3.5355	12.5000	(2)
	L.	13.7778	3.8006	14.4444	(9)
	M.	11.9000	2.2828	5.2111	(10)
	O.	16.2222	4.0242	16.1944	(9)
	Q.	16.1667	5.9805	35.7667	(6)
	R.	11.6250	3.9619	15.6964	(8)
	T.	13.6000	3.5777	12.8000	(5)
7.	R.	10.0588	3.1912	10.1838	(17)

Character C16 MLF Number Of Lobes

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	7.4545	0.6876	0.4727	(11)
	B.	7.5000	0.8498	0.7222	(10)
	C.	7.5000	0.7071	0.5000	(10)
	D.	7.5000	1.0801	1.1667	(10)
	E.	9.0526	0.7050	0.4971	(19)
	F.	8.4000	0.5164	0.2667	(10)
	G.	8.5000	0.7071	0.5000	(2)
	H.	8.7000	0.6749	0.4556	(10)
	I.	7.9500	0.7592	0.5763	(20)
	J.	8.1000	0.7182	0.5158	(20)
	K.	7.5000	1.0801	1.1667	(10)
	L.	8.1667	0.7528	0.5667	(6)
	M.	9.1667	0.4082	0.1667	(6)
	N.	8.3500	0.9333	0.8711	(20)
	O.	8.8125	0.5439	0.2958	(16)
	P.	8.5000	0.8498	0.7222	(10)
	Q.	7.5000	0.9718	0.9444	(10)
	R.	8.3077	0.9473	0.8974	(13)
	S.	8.3889	0.9785	0.9575	(18)
	T.	9.1000	0.9679	0.9368	(20)
	U.	8.0000	0.9177	0.8421	(20)
2.	M.	8.7000	0.9487	0.9000	(10)
	N.	8.5789	0.8377	0.7018	(19)
	O.	8.2353	0.8314	0.6912	(17)
	Q.	7.4000	0.6992	0.4889	(10)
	R.	7.0000	0.0000	0.0000	(1)
	T.	9.3000	0.9787	0.9579	(20)
	U.	8.9500	1.3563	1.8395	(20)
3.	N.	8.0000	1.4142	2.0000	(2)
	Q.	9.0000	0.0000	0.0000	(1)
4.	K.	7.0000	1.0000	1.0000	(3)
	L.	5.8889	1.0541	1.1111	(9)
	M.	7.4000	0.8944	0.8000	(5)
	N.	7.7059	0.9852	0.9706	(17)
	O.	7.1000	1.2867	1.6556	(10)
	P.	6.6667	0.5164	0.2667	(6)
	T.	6.8889	1.0541	1.1111	(9)
	U.	6.6667	0.5774	0.3333	(3)
5.	L.	7.8000	0.8367	0.7000	(5)
	M.	9.0000	0.8165	0.6667	(10)
	O.	8.5000	0.5774	0.3333	(4)
6.	G.	10.2000	0.8367	0.7000	(5)
	H.	9.6667	0.5774	0.3333	(3)
	K.	9.0000	0.0000	0.0000	(2)
	L.	10.0000	1.0000	1.0000	(9)
	M.	9.1000	0.8756	0.7667	(10)
	O.	9.1111	0.6009	0.3611	(9)
	Q.	9.5000	0.8367	0.7000	(6)
	R.	9.2500	0.7071	0.5000	(8)
	T.	9.0000	0.0000	0.0000	(5)
7.	R.	11.2353	0.8314	0.6912	(17)

Character C20 MLF Midlobe Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	14.6364	3.2333	10.4545	(11)
	B.	17.5000	4.9944	24.9444	(10)
	C.	15.0000	3.6818	13.5556	(10)
	D.	16.2000	4.0222	16.1778	(10)
	E.	23.7368	3.0339	9.2047	(19)
	F.	19.0000	1.4142	2.0000	(10)
	G.	30.5000	3.5355	12.5000	(2)
	H.	19.5000	1.6499	2.7222	(10)
	I.	19.0000	4.2920	18.4211	(20)
	J.	21.8000	4.5607	20.8000	(20)
	K.	22.3000	4.9227	24.2333	(10)
	L.	21.3333	3.3267	11.0667	(6)
	M.	19.5000	2.5884	6.7000	(6)
	N.	23.9500	3.3635	11.3132	(20)
	O.	19.3125	5.3879	29.0292	(16)
	P.	17.8000	2.4404	5.9556	(10)
	Q.	21.0000	7.0396	49.5556	(10)
	R.	22.3077	4.2892	18.3974	(13)
	S.	23.3889	4.8159	23.1928	(18)
	T.	25.7000	6.1993	38.4316	(20)
	U.	25.2000	6.7325	45.3263	(20)
2.	M.	21.5000	5.9861	35.8333	(10)
	N.	23.1579	4.9020	24.0292	(19)
	O.	19.5882	4.2875	18.3824	(17)
	Q.	27.9000	4.1218	16.9889	(10)
	R.	19.0000	0.0000	0.0000	(1)
	T.	25.1000	5.3988	29.1474	(20)
	U.	21.4000	4.0962	16.7789	(20)
3.	N.	24.5000	2.1213	4.5000	(2)
	Q.	16.0000	0.0000	0.0000	(1)
4.	K.	34.0000	10.1489	103.0000	(3)
	L.	24.1111	6.2339	38.8611	(9)
	M.	50.8000	11.4105	130.2000	(5)
	N.	41.2941	5.1813	26.8456	(17)
	O.	33.6000	11.3157	128.0444	(10)
	P.	37.3333	7.5277	56.6667	(6)
	T.	40.2222	10.7561	115.6944	(9)
	U.	36.3333	11.5902	134.3333	(3)
5.	L.	17.4000	2.0736	4.3000	(5)
	M.	27.5000	5.6224	31.6111	(10)
	O.	27.7500	12.7639	162.9167	(4)
6.	G.	43.2000	3.4205	11.7000	(5)
	H.	22.0000	6.2450	39.0000	(3)
	K.	32.0000	11.3137	128.0000	(2)
	L.	22.1111	4.3429	18.8611	(9)
	M.	19.3000	3.0203	9.1222	(10)
	O.	27.0000	4.0927	16.7500	(9)
	Q.	25.6667	6.4704	41.8667	(6)
	R.	22.5000	9.4415	89.1429	(8)
	T.	24.2000	4.3243	18.7000	(5)
7.	R.	26.1765	7.6341	58.2794	(17)

Character C21 MLF Midlobe Max Width A

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	4.6364	0.6742	0.4545	(11)
	B.	5.0000	0.9428	0.8889	(10)
	C.	4.5000	1.0801	1.1667	(10)
	D.	6.3000	3.5606	12.6778	(10)
	E.	6.3684	1.1648	1.3567	(19)
	F.	4.7000	0.4830	0.2333	(10)
	G.	4.0000	0.0000	0.0000	(2)
	H.	3.2000	0.7888	0.6222	(10)
	I.	4.9000	0.7182	0.5158	(20)
	J.	5.1000	0.9679	0.9368	(20)
	K.	5.2000	1.8738	3.5111	(10)
	L.	5.1667	0.9832	0.9667	(6)
	M.	4.6667	0.5164	0.2667	(6)
	N.	5.3500	0.9333	0.8711	(20)
	O.	3.7500	1.3904	1.9333	(16)
	P.	4.0000	0.9428	0.8889	(10)
	Q.	5.0000	1.8856	3.5556	(10)
	R.	4.1538	0.8987	0.8077	(13)
	S.	4.6111	1.3779	1.8987	(18)
	T.	4.4500	0.8256	0.6816	(20)
	U.	5.4000	1.1877	1.4105	(20)
2.	M.	4.9000	1.7920	3.2111	(10)
	N.	4.7368	1.4080	1.9825	(19)
	O.	4.8235	1.9760	3.9044	(17)
	Q.	6.3000	0.9487	0.9000	(10)
	R.	3.0000	0.0000	0.0000	(1)
	T.	5.8500	2.0072	4.0289	(20)
	U.	4.2500	1.2927	1.6711	(20)
3.	N.	5.0000	1.4142	2.0000	(2)
	Q.	3.0000	0.0000	0.0000	(1)
4.	K.	3.6667	1.1547	1.3333	(3)
	L.	4.2222	0.6667	0.4444	(9)
	M.	7.0000	1.2247	1.5000	(5)
	N.	4.0000	0.6124	0.3750	(17)
	O.	4.0000	1.5635	2.4444	(10)
	P.	3.1667	0.7528	0.5667	(6)
	T.	4.4444	1.0138	1.0278	(9)
	U.	4.3333	1.5275	2.3333	(3)
5.	L.	3.6000	0.5477	0.3000	(5)
	M.	5.0000	1.6330	2.6667	(10)
	O.	5.5000	1.9149	3.6667	(4)
6.	G.	8.4000	2.5100	6.3000	(5)
	H.	7.6667	1.5275	2.3333	(3)
	K.	8.0000	1.4142	2.0000	(2)
	L.	5.4444	1.1304	1.2778	(9)
	M.	4.7000	0.4830	0.2333	(10)
	O.	6.0000	1.0000	1.0000	(9)
	Q.	5.6667	1.7512	3.0667	(6)
	R.	6.1250	2.9970	8.9821	(8)
	T.	6.6000	1.1402	1.3000	(5)
7.	R.	4.8235	1.2862	1.6544	(17)

Character C22 MLF Midlobe Midrib To Max Width A

Spp.	Popn.	Mean	Std. dev.	Variance	n.
1.	A.	9.7273	1.9540	3.8182	(11)
	B.	12.1000	5.8585	34.3222	(10)
	C.	10.6000	3.2387	10.4889	(10)
	D.	9.8000	2.3944	5.7333	(10)
	E.	13.0000	2.5604	6.5556	(19)
	F.	8.9000	1.3703	1.8778	(10)
	G.	18.5000	7.7782	60.5000	(2)
	H.	8.8000	1.0328	1.0667	(10)
	I.	9.9500	3.5759	12.7868	(20)
	J.	11.5000	2.9110	8.4737	(20)
	K.	10.9000	2.6013	6.7667	(10)
	L.	10.5000	1.7607	3.1000	(6)
	M.	9.8333	1.3292	1.7667	(6)
	N.	11.2000	2.3079	5.3263	(20)
	O.	10.7500	4.3436	18.8667	(16)
	P.	8.0000	1.3333	1.7778	(10)
	Q.	9.5000	3.8944	15.1667	(10)
	R.	11.3077	1.7505	3.0641	(13)
	S.	10.6111	1.8830	3.5458	(18)
	T.	10.4000	3.2020	10.2526	(20)
	U.	10.2500	3.0586	9.3553	(20)
2.	M.	11.7000	6.0928	37.1222	(10)
	N.	9.8947	3.1954	10.2105	(19)
	O.	8.7059	2.7103	7.3456	(17)
	Q.	10.0000	1.1547	1.3333	(10)
	R.	5.0000	0.0000	0.0000	(1)
	T.	8.9000	1.7741	3.1474	(20)
	U.	10.0500	2.5438	6.4711	(20)
3.	N.	10.5000	2.1213	4.5000	(2)
	Q.	8.0000	0.0000	0.0000	(1)
4.	K.	22.0000	3.6056	13.0000	(3)
	L.	14.4444	5.0525	25.5278	(9)
	M.	36.6000	12.4419	154.8000	(5)
	N.	24.1176	4.9102	24.1103	(17)
	O.	19.2000	5.4119	29.2889	(10)
	P.	22.0000	6.0992	37.2000	(6)
	T.	27.2222	8.2277	67.6944	(9)
	U.	24.6667	3.5119	12.3333	(3)
5.	L.	13.0000	2.2361	5.0000	(5)
	M.	18.9000	4.8178	23.2111	(10)
	O.	22.0000	12.5167	156.6667	(4)
6.	G.	25.8000	5.7619	33.2000	(5)
	H.	15.0000	6.0828	37.0000	(3)
	K.	25.0000	11.3137	128.0000	(2)
	L.	14.3333	3.7081	13.7500	(9)
	M.	13.4000	3.4383	11.8222	(10)
	O.	21.1111	5.1343	26.3611	(9)
	Q.	15.8333	3.3116	10.9667	(6)
	R.	14.3750	6.7387	45.4107	(8)
	T.	16.6000	3.1305	9.8000	(5)
7.	R.	15.3529	5.5671	30.9926	(17)

Character C23 MLF Midlobe Max Width B

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	4.2727	1.0090	1.0182	(11)
	B.	5.3000	1.4944	2.2333	(10)
	C.	4.3000	1.1595	1.3444	(10)
	D.	5.2000	1.2293	1.5111	(10)
	E.	6.0526	0.8481	0.7193	(19)
	F.	4.6000	0.8433	0.7111	(10)
	G.	5.5000	0.7071	0.5000	(2)
	H.	3.3000	0.4830	0.2333	(10)
	I.	5.0000	0.8584	0.7368	(20)
	J.	5.5500	0.8256	0.6816	(20)
	K.	5.2000	1.7512	3.0667	(10)
	L.	5.0000	0.6325	0.4000	(6)
	M.	4.5000	0.5477	0.3000	(6)
	N.	4.6500	0.8751	0.7658	(20)
	O.	4.1250	0.8851	0.7833	(16)
	P.	4.4000	0.6992	0.4889	(10)
	Q.	3.4000	0.8433	0.7111	(10)
	R.	4.6923	1.1094	1.2308	(13)
	S.	5.2222	1.3086	1.7124	(18)
	T.	5.2000	1.1965	1.4316	(20)
	U.	5.3000	0.9787	0.9579	(20)
2.	M.	5.0000	1.3333	1.7778	(10)
	N.	4.5263	1.5765	2.4854	(19)
	O.	4.2353	1.4374	2.0662	(17)
	Q.	5.7000	0.9487	0.9000	(10)
	R.	3.0000	0.0000	0.0000	(1)
	T.	5.0500	1.5035	2.2605	(20)
	U.	4.8000	1.3219	1.7474	(20)
3.	N.	4.5000	2.1213	4.5000	(2)
	Q.	4.0000	0.0000	0.0000	(1)
4.	K.	6.6667	2.5166	6.3333	(3)
	L.	3.7778	1.3017	1.6944	(9)
	M.	9.8000	1.9235	3.7000	(5)
	N.	5.6471	0.9963	0.9926	(17)
	O.	6.1000	4.0401	16.3222	(10)
	P.	5.1667	1.6021	2.5667	(6)
	T.	6.8889	1.5366	2.3611	(9)
	U.	6.3333	2.3094	5.3333	(3)
5.	L.	4.0000	0.7071	0.5000	(5)
	M.	6.8000	1.3984	1.9556	(10)
	O.	7.2500	3.7749	14.2500	(4)
6.	G.	9.0000	4.6368	21.5000	(5)
	H.	7.0000	2.6458	7.0000	(3)
	K.	10.0000	2.8284	8.0000	(2)
	L.	6.8889	1.2693	1.6111	(9)
	M.	8.8000	1.5492	2.4000	(10)
	O.	7.8889	2.5221	6.3611	(9)
	Q.	6.8333	2.7869	7.7667	(6)
	R.	6.6250	2.4458	5.9821	(8)
	T.	5.8000	1.4832	2.2000	(5)
7.	R.	6.6471	2.7143	7.3676	(17)

Character C24 MLF Midlobe Midrib to Max Width B

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	10.1818	2.7502	7.5636	(11)
	B.	11.4000	3.4383	11.8222	(10)
	C.	9.5000	2.0138	4.0556	(10)
	D.	10.8000	3.0840	9.5111	(10)
	E.	12.7895	3.7354	13.9532	(19)
	F.	11.0000	1.7638	3.1111	(10)
	G.	14.5000	0.7071	0.5000	(2)
	H.	8.4000	1.0750	1.1556	(10)
	I.	8.7000	2.9397	8.6421	(20)
	J.	10.6500	2.8887	8.3447	(20)
	K.	10.5000	4.1700	17.3889	(10)
	L.	9.8333	1.4720	2.1667	(6)
	M.	8.8333	1.4720	2.1667	(6)
	N.	12.2500	2.4895	6.1974	(20)
	O.	9.3750	2.4187	5.8500	(16)
	P.	9.2000	1.7512	3.0667	(10)
	Q.	6.3000	3.2335	10.4556	(10)
	R.	7.1538	2.9111	8.4744	(13)
	S.	10.8889	3.6924	13.6340	(18)
	T.	12.2000	5.0845	25.8526	(20)
	U.	9.4500	2.4597	6.0500	(20)
2.	M.	11.5000	2.3688	5.6111	(10)
	N.	9.6842	3.1279	9.7836	(19)
	O.	8.8235	3.8768	15.0294	(17)
	Q.	12.7000	4.1110	16.9000	(10)
	R.	5.0000	0.0000	0.0000	(1)
	T.	9.2500	2.3592	5.5658	(20)
	U.	11.4500	4.6394	21.5237	(20)
3.	N.	6.5000	0.7071	0.5000	(2)
	Q.	5.0000	0.0000	0.0000	(1)
4.	K.	13.6667	8.0829	65.3333	(3)
	L.	12.1111	3.8550	14.8611	(9)
	M.	32.0000	12.7475	162.5000	(5)
	N.	18.5294	4.6786	21.8897	(17)
	O.	17.1000	7.1717	51.4333	(10)
	P.	17.6667	4.6762	21.8667	(6)
	T.	26.2222	8.7003	75.6944	(9)
	U.	18.3333	3.5119	12.3333	(3)
5.	L.	12.4000	0.5477	0.3000	(5)
	M.	17.0000	3.6818	13.5556	(10)
	O.	18.5000	9.4692	89.6667	(4)
6.	G.	20.8000	5.3572	28.7000	(5)
	H.	12.0000	6.2450	39.0000	(3)
	K.	20.0000	7.0711	50.0000	(2)
	L.	11.8889	4.3716	19.1111	(9)
	M.	11.5000	3.3082	10.9444	(10)
	O.	14.4444	3.8766	15.0278	(9)
	Q.	12.8333	3.5449	12.5667	(6)
	R.	13.6250	5.8782	34.5536	(8)
	T.	14.4000	2.9665	8.8000	(5)
7.	R.	10.5882	4.9882	24.8824	(17)

Character C25 MLF Midlobe Apical Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	4.0909	1.0445	1.0909	(11)
	B.	3.5000	0.5270	0.2778	(10)
	C.	3.5000	0.5270	0.2778	(10)
	D.	4.9000	3.2813	10.7667	(10)
	E.	4.4211	0.6925	0.4795	(19)
	F.	4.2000	0.6325	0.4000	(10)
	G.	5.5000	0.7071	0.5000	(2)
	H.	3.3000	0.4830	0.2333	(10)
	I.	4.4500	0.8256	0.6816	(20)
	J.	4.7000	1.1286	1.2737	(20)
	K.	5.3000	1.6364	2.6778	(10)
	L.	4.5000	0.5477	0.3000	(6)
	M.	3.1667	0.4082	0.1667	(6)
	N.	3.6000	0.9403	0.8842	(20)
	O.	3.6875	1.3022	1.6958	(16)
	P.	3.4000	0.8433	0.7111	(10)
	Q.	2.5000	0.7071	0.5000	(10)
	R.	3.6923	0.7511	0.5641	(13)
	S.	3.9444	0.7254	0.5261	(18)
	T.	3.4500	0.7592	0.5763	(20)
	U.	4.9500	0.9445	0.8921	(20)
2.	M.	2.7000	0.6749	0.4556	(10)
	N.	2.7368	0.8719	0.7602	(19)
	O.	2.2941	0.4697	0.2206	(17)
	Q.	2.7000	0.4830	0.2333	(10)
	R.	2.0000	0.0000	0.0000	(1)
	T.	2.8000	1.1517	1.3263	(20)
	U.	2.9500	1.0501	1.1026	(20)
3.	N.	2.5000	0.7071	0.5000	(2)
	Q.	3.0000	0.0000	0.0000	(1)
4.	K.	5.3333	1.5275	2.3333	(3)
	L.	2.7778	0.6667	0.4444	(9)
	M.	4.6000	0.8944	0.8000	(5)
	N.	3.8824	0.7812	0.6103	(17)
	O.	4.6000	1.3499	1.8222	(10)
	P.	4.6667	1.0328	1.0667	(6)
	T.	5.3333	1.2247	1.5000	(9)
	U.	5.0000	1.0000	1.0000	(3)
5.	L.	3.4000	0.5477	0.3000	(5)
	M.	4.8000	0.9189	0.8444	(10)
	O.	5.2500	1.5000	2.2500	(4)
6.	G.	8.2000	1.9235	3.7000	(5)
	H.	5.3333	0.5774	0.3333	(3)
	K.	5.5000	0.7071	0.5000	(2)
	L.	4.8889	0.6009	0.3611	(9)
	M.	4.6000	0.5164	0.2667	(10)
	O.	5.6667	0.7071	0.5000	(9)
	Q.	5.0000	0.6325	0.4000	(6)
	R.	4.6250	1.5980	2.5536	(8)
	T.	4.8000	0.8367	0.7000	(5)
7.	R.	4.1765	1.4246	2.0294	(17)

Character C26 MLF Midlobe Basal Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	9.7273	1.1037	1.2182	(11)
	B.	10.8000	2.4404	5.9556	(10)
	C.	10.5000	3.2404	10.5000	(10)
	D.	11.2000	1.8135	3.2889	(10)
	E.	12.5263	1.8064	3.2632	(19)
	F.	9.5000	1.0801	1.1667	(10)
	G.	9.5000	0.7071	0.5000	(2)
	H.	8.0000	0.6667	0.4444	(10)
	I.	10.0500	2.3946	5.7342	(20)
	J.	10.3500	1.1821	1.3974	(20)
	K.	11.3000	2.8694	8.2333	(10)
	L.	11.1667	1.4720	2.1667	(6)
	M.	7.1667	1.1690	1.3667	(6)
	N.	9.5000	2.8191	7.9474	(20)
	O.	8.4375	2.6575	7.0625	(16)
	P.	8.0000	1.7638	3.1111	(10)
	Q.	9.3000	2.1108	4.4556	(10)
	R.	10.0769	1.9774	3.9103	(13)
	S.	9.3889	1.9745	3.8987	(18)
	T.	10.2000	2.1667	4.6947	(20)
	U.	10.0500	2.2118	4.8921	(20)
2.	M.	8.9000	3.1073	9.6556	(10)
	N.	6.8947	1.1970	1.4327	(19)
	O.	7.8235	2.2426	5.0294	(17)
	Q.	9.5000	0.8498	0.7222	(10)
	R.	8.0000	0.0000	0.0000	(1)
	T.	8.8500	1.7554	3.0816	(20)
	U.	8.5500	2.0125	4.0500	(20)
3.	N.	9.0000	4.2426	18.0000	(2)
	Q.	8.0000	0.0000	0.0000	(1)
4.	K.	6.0000	0.0000	0.0000	(3)
	L.	3.6667	0.7071	0.5000	(9)
	M.	6.2000	2.7749	7.7000	(5)
	N.	7.7059	1.3585	1.8456	(17)
	O.	6.3000	2.1628	4.6778	(10)
	P.	6.8333	1.9408	3.7667	(6)
	T.	7.1111	1.5366	2.3611	(9)
	U.	10.6667	3.7859	14.3333	(3)
5.	L.	3.2000	0.4472	0.2000	(5)
	M.	7.0000	2.3094	5.3333	(10)
	O.	8.5000	5.3229	28.3333	(4)
6.	G.	6.8000	0.8367	0.7000	(5)
	H.	4.3333	0.5774	0.3333	(3)
	K.	4.5000	0.7071	0.5000	(2)
	L.	4.6667	1.0000	1.0000	(9)
	M.	4.5000	1.0801	1.1667	(10)
	O.	4.6667	0.8660	0.7500	(9)
	Q.	4.3333	0.5164	0.2667	(6)
	R.	4.6250	1.3025	1.6964	(8)
	T.	4.4000	0.8944	0.8000	(5)
7.	R.	4.1765	1.1311	1.2794	(17)

Character C27 MLF Midlobe Lamina Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	4.3636	0.8090	0.6545	(11)
	B.	4.9000	1.6633	2.7667	(10)
	C.	4.1000	0.7379	0.5444	(10)
	D.	4.7000	1.6364	2.6778	(10)
	E.	4.8947	0.8753	0.7661	(19)
	F.	3.9000	0.5676	0.3222	(10)
	G.	4.0000	1.4142	2.0000	(2)
	H.	3.7000	0.4830	0.2333	(10)
	I.	3.7500	0.7164	0.5132	(20)
	J.	3.9500	0.8256	0.6816	(20)
	K.	5.2000	1.8135	3.2889	(10)
	L.	4.5000	0.5477	0.3000	(6)
	M.	2.8333	0.4082	0.1667	(6)
	N.	3.4500	0.6048	0.3658	(20)
	O.	3.1250	1.0878	1.1833	(16)
	P.	3.0000	0.4714	0.2222	(10)
	Q.	3.1000	0.8756	0.7667	(10)
	R.	3.6154	0.7679	0.5897	(13)
	S.	3.2222	0.4278	0.1830	(18)
	T.	3.7000	0.9787	0.9579	(20)
	U.	3.9500	1.0501	1.1026	(20)
2.	M.	3.3000	1.0593	1.1222	(10)
	N.	2.6316	0.5973	0.3567	(19)
	O.	2.3529	0.4926	0.2426	(17)
	Q.	2.6000	0.5164	0.2667	(10)
	R.	3.0000	0.0000	0.0000	(1)
	T.	2.8000	0.7678	0.5895	(20)
	U.	2.7500	0.7164	0.5132	(20)
3.	N.	3.5000	0.7071	0.5000	(2)
	Q.	4.0000	0.0000	0.0000	(1)
4.	K.	2.6667	0.5774	0.3333	(3)
	L.	2.1111	0.3333	0.1111	(9)
	M.	2.6000	1.1402	1.3000	(5)
	N.	3.0000	0.6124	0.3750	(17)
	O.	2.5000	0.5270	0.2778	(10)
	P.	3.6667	1.6330	2.6667	(6)
	T.	3.5556	0.8819	0.7778	(9)
	U.	4.0000	1.0000	1.0000	(3)
5.	L.	1.0000	0.0000	0.0000	(5)
	M.	2.3000	0.9487	0.9000	(10)
	O.	2.7500	1.2583	1.5833	(4)
6.	G.	2.0000	0.7071	0.5000	(5)
	H.	2.0000	0.0000	0.0000	(3)
	K.	2.0000	0.0000	0.0000	(2)
	L.	1.6667	0.7071	0.5000	(9)
	M.	2.1000	0.5676	0.3222	(10)
	O.	1.5556	0.5270	0.2778	(9)
	Q.	1.6667	0.8165	0.6667	(6)
	R.	1.7500	0.4629	0.2143	(8)
	T.	1.8000	0.4472	0.2000	(5)
7.	R.	1.7059	0.7717	0.5956	(17)

Character C28 MLF Intercostal Length A

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	11.9091	1.4460	2.0909	(11)
	B.	15.2000	2.6998	7.2889	(10)
	C.	12.1000	2.9981	8.9889	(10)
	D.	14.2000	2.0440	4.1778	(10)
	E.	13.3158	2.6045	6.7836	(19)
	F.	12.2000	1.4757	2.1778	(10)
	G.	19.0000	7.0711	50.0000	(2)
	H.	12.8000	2.0440	4.1778	(10)
	I.	11.4000	2.7606	7.6211	(20)
	J.	12.7500	2.8996	8.4079	(20)
	K.	12.9000	2.9609	8.7667	(10)
	L.	14.8333	3.3116	10.9667	(6)
	M.	10.3333	1.5055	2.2667	(6)
	N.	13.1000	2.9895	8.9368	(20)
	O.	10.1250	2.5000	6.2500	(16)
	P.	10.2000	1.2293	1.5111	(10)
	Q.	9.9000	4.5326	20.5444	(10)
	R.	13.6923	3.8813	15.0641	(13)
	S.	14.1111	2.6983	7.2810	(18)
	T.	13.7500	2.1244	4.5132	(20)
	U.	14.0000	3.2767	10.7368	(20)
2.	M.	11.6000	3.0984	9.6000	(10)
	N.	12.3684	2.5432	6.4678	(19)
	O.	10.5294	2.8530	8.1397	(17)
	Q.	12.1000	2.0248	4.1000	(10)
	R.	12.0000	0.0000	0.0000	(1)
	T.	9.5500	1.5381	2.3658	(20)
	U.	11.7500	2.9357	8.6184	(20)
3.	N.	12.0000	1.4142	2.0000	(2)
	Q.	12.0000	0.0000	0.0000	(1)
4.	K.	18.6667	2.5166	6.3333	(3)
	L.	11.1111	2.6667	7.1111	(9)
	M.	26.8000	6.0581	36.7000	(5)
	N.	22.0588	4.3799	19.1838	(17)
	O.	16.3000	5.4375	29.5667	(10)
	P.	15.5000	1.0488	1.1000	(6)
	T.	19.2222	2.5874	6.6944	(9)
	U.	15.0000	1.0000	1.0000	(3)
5.	L.	8.8000	1.9235	3.7000	(5)
	M.	12.6000	2.9136	8.4889	(10)
	O.	17.5000	10.5357	111.0000	(4)
6.	G.	18.2000	2.5884	6.7000	(5)
	H.	11.3333	2.0817	4.3333	(3)
	K.	16.0000	2.8284	8.0000	(2)
	L.	10.1111	2.2048	4.8611	(9)
	M.	12.0000	2.3094	5.3333	(10)
	O.	12.3333	2.6458	7.0000	(9)
	Q.	12.3333	2.2509	5.0667	(6)
	R.	11.3750	3.1139	9.6964	(8)
	T.	11.8000	1.6432	2.7000	(5)
7.	R.	11.8235	4.4474	19.7794	(17)

Character C29 MLF Intercostal Length B

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	15.9091	3.2390	10.4909	(11)
	B.	17.4000	3.6576	13.3778	(10)
	C.	13.8000	2.7809	7.7333	(10)
	D.	15.4000	3.3731	11.3778	(10)
	E.	16.4737	2.9883	8.9298	(19)
	F.	14.0000	1.7638	3.1111	(10)
	G.	20.5000	7.7782	60.5000	(2)
	H.	12.7000	1.6364	2.6778	(10)
	I.	11.8500	2.1831	4.7658	(20)
	J.	12.9000	2.1497	4.6211	(20)
	K.	16.9000	6.0083	36.1000	(10)
	L.	16.0000	4.7329	22.4000	(6)
	M.	12.6667	2.9439	8.6667	(6)
	N.	14.6000	3.3309	11.0947	(20)
	O.	10.5000	3.0111	9.0667	(16)
	P.	12.2000	2.0440	4.1778	(10)
	Q.	10.8000	5.0288	25.2889	(10)
	R.	15.7692	3.7003	13.6923	(13)
	S.	15.6667	3.5810	12.8235	(18)
	T.	13.7500	3.4470	11.8816	(20)
	U.	15.6500	3.8970	15.1868	(20)
2.	M.	11.5000	3.0641	9.3889	(10)
	N.	12.3684	2.7931	7.8012	(19)
	O.	10.8235	2.6513	7.0294	(17)
	Q.	10.4000	1.9551	3.8222	(10)
	R.	10.0000	0.0000	0.0000	(1)
	T.	9.9000	1.2937	1.6737	(20)
	U.	13.3500	3.7031	13.7132	(20)
3.	N.	12.5000	3.5355	12.5000	(2)
	Q.	10.0000	0.0000	0.0000	(1)
4.	K.	15.0000	3.4641	12.0000	(3)
	L.	10.0000	3.1225	9.7500	(9)
	M.	10.4000	2.7019	7.3000	(5)
	N.	13.2941	3.8367	14.7206	(17)
	O.	13.8000	5.9404	35.2889	(10)
	P.	11.1667	6.6458	44.1667	(6)
	T.	16.6667	4.3589	19.0000	(9)
	U.	14.0000	5.5678	31.0000	(3)
5.	L.	6.6000	1.9494	3.8000	(5)
	M.	12.1000	4.0675	16.5444	(10)
	O.	16.2500	7.9739	63.5833	(4)
6.	G.	16.4000	2.6077	6.8000	(5)
	H.	9.6667	1.5275	2.3333	(3)
	K.	12.5000	0.7071	0.5000	(2)
	L.	9.3333	2.5000	6.2500	(9)
	M.	9.0000	2.2608	5.1111	(10)
	O.	10.1111	1.7638	3.1111	(9)
	Q.	10.5000	3.0166	9.1000	(6)
	R.	9.5000	2.1381	4.5714	(8)
	T.	10.2000	1.4832	2.2000	(5)
7.	R.	12.6471	2.4223	5.8676	(17)

Character C31 MLF Apical Angle B

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	106.1818	6.1452	37.7636	(11)
	B.	105.5000	6.8840	47.3889	(10)
	C.	98.5000	7.0907	50.2778	(10)
	D.	106.3000	5.3759	28.9000	(10)
	E.	104.8421	8.4015	70.5848	(19)
	F.	101.0000	5.3955	29.1111	(10)
	G.	116.0000	22.6274	512.0000	(2)
	H.	103.1000	4.5570	20.7667	(10)
	I.	104.2000	5.1052	26.0632	(20)
	J.	103.4500	7.3375	53.8395	(20)
	K.	97.0000	5.0772	25.7778	(10)
	L.	100.8333	7.0261	49.3667	(6)
	M.	107.0000	8.8769	78.8000	(6)
	N.	110.1000	12.6819	160.8316	(20)
	O.	109.6875	7.2730	52.8958	(16)
	P.	108.1000	16.3466	267.2111	(10)
	Q.	105.5000	4.9046	24.0556	(10)
	R.	100.8462	8.7259	76.1410	(13)
	S.	102.3889	15.2784	233.4281	(18)
	T.	111.5500	8.1723	66.7868	(20)
	U.	109.0000	5.3213	28.3158	(20)
2.	M.	108.8000	5.3707	28.8444	(10)
	N.	102.9474	15.5616	242.1637	(19)
	O.	102.2941	6.9621	48.4706	(17)
	Q.	130.2000	29.5101	870.8444	(10)
	R.	112.0000	0.0000	0.0000	(1)
	T.	102.3500	9.8797	97.6079	(20)
	U.	105.1000	9.1416	83.5684	(20)
3.	N.	111.5000	10.6066	112.5000	(2)
	Q.	92.0000	0.0000	0.0000	(1)
4.	K.	87.3333	17.5594	308.3333	(3)
	L.	91.0000	8.1854	67.0000	(9)
	M.	82.8000	6.4187	41.2000	(5)
	N.	85.1765	9.2954	86.4044	(17)
	O.	86.5000	13.4185	180.0556	(10)
	P.	93.3333	4.7610	22.6667	(6)
	T.	95.8889	13.8964	193.1111	(9)
	U.	94.0000	5.2915	28.0000	(3)
5.	L.	92.0000	9.9499	99.0000	(5)
	M.	92.8000	9.4962	90.1778	(10)
	O.	95.7500	9.6393	92.9167	(4)
6.	G.	105.4000	7.3007	53.3000	(5)
	H.	107.6667	10.5040	110.3333	(3)
	K.	97.5000	10.6066	112.5000	(2)
	L.	108.5556	11.1928	125.2778	(9)
	M.	114.6000	6.5862	43.3778	(10)
	O.	109.1111	10.1912	103.8611	(9)
	Q.	111.0000	9.5708	91.6000	(6)
	R.	106.0000	8.5690	73.4286	(8)
	T.	111.0000	9.5656	91.5000	(5)
7.	R.	97.7059	9.5901	91.9706	(17)

Character C32 MLF Basal Angle A

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	41.9091	8.5610	73.2909	(11)
	B.	60.4000	19.0683	363.6000	(10)
	C.	47.8000	6.6633	44.4000	(10)
	D.	46.5000	10.5751	111.8333	(10)
	E.	61.2105	9.5019	90.2865	(19)
	F.	56.2000	11.6981	136.8444	(10)
	G.	55.5000	0.7071	0.5000	(2)
	H.	44.7000	4.1110	16.9000	(10)
	I.	44.5500	5.6240	31.6289	(20)
	J.	45.2500	5.7571	33.1447	(20)
	K.	55.6000	8.8217	77.8222	(10)
	L.	49.1667	6.3061	39.7667	(6)
	M.	66.3333	3.5024	12.2667	(6)
	N.	65.5500	10.5105	110.4711	(20)
	O.	57.2500	6.1590	37.9333	(16)
	P.	49.9000	8.1711	66.7667	(10)
	Q.	69.0000	5.1640	26.6667	(10)
	R.	56.4615	9.9383	98.7692	(13)
	S.	51.1111	10.1337	102.6928	(18)
	T.	58.0000	11.8455	140.3158	(20)
	U.	53.6500	9.1552	83.8184	(20)
2.	M.	75.7000	8.0836	65.3444	(10)
	N.	68.3684	12.3208	151.8012	(19)
	O.	64.6471	11.5485	133.3676	(17)
	Q.	78.2000	3.7947	14.4000	(10)
	R.	50.0000	0.0000	0.0000	(1)
	T.	63.2500	7.9065	62.5132	(20)
3.	U.	60.8000	14.0510	197.4316	(20)
	N.	75.5000	14.8492	220.5000	(2)
	Q.	69.0000	0.0000	0.0000	(1)
4.	K.	75.6667	16.2583	264.3333	(3)
	L.	71.0000	6.0622	36.7500	(9)
	M.	75.6000	11.1041	123.3000	(5)
	N.	61.0588	12.1628	147.9338	(17)
	O.	68.9000	10.3113	106.3222	(10)
	P.	81.6667	4.6332	21.4667	(6)
	T.	68.3333	20.7002	428.5000	(9)
	U.	53.3333	8.0208	64.3333	(3)
5.	L.	63.8000	8.7579	76.7000	(5)
	M.	70.0000	3.1623	10.0000	(10)
	O.	73.7500	4.0311	16.2500	(4)
6.	G.	66.6000	6.8775	47.3000	(5)
	H.	74.6667	15.1767	230.3333	(3)
	K.	79.0000	42.4264	1800.0000	(2)
	L.	71.0000	19.7864	391.5000	(9)
	M.	69.7000	16.6603	277.5667	(10)
	O.	73.4444	15.9931	255.7778	(9)
	Q.	75.6667	17.3743	301.8667	(6)
	R.	69.6250	8.5847	73.6964	(8)
	T.	65.6000	5.5498	30.8000	(5)
7.	R.	66.8235	11.5987	134.5294	(17)

Character C33 MLF Basal Angle B

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	147.7273	15.2190	231.6182	(11)
	B.	114.1000	35.2371	1241.6556	(10)
	C.	129.9000	16.8816	284.9889	(10)
	D.	163.1000	32.4601	1053.6556	(10)
	E.	129.8947	23.9302	572.6550	(19)
	F.	134.3000	15.7695	248.6778	(10)
	G.	125.0000	19.7990	392.0000	(2)
	H.	156.7000	20.1387	405.5667	(10)
	I.	159.9000	26.2757	690.4105	(20)
	J.	165.9500	32.1354	1032.6816	(20)
	K.	117.3000	14.6898	215.7889	(10)
	L.	159.6667	30.3227	919.4667	(6)
	M.	99.0000	47.8581	2290.4000	(6)
	N.	123.0000	14.2349	202.6316	(20)
	O.	139.6875	24.0907	580.3625	(16)
	P.	129.0000	16.0624	258.0000	(10)
	Q.	179.9000	21.7330	472.3222	(10)
	R.	143.0769	32.4640	1053.9103	(13)
	S.	136.8889	33.2705	1106.9281	(18)
	T.	126.9500	26.6527	710.3658	(20)
	U.	142.5000	34.6129	1198.0526	(20)
2.	M.	130.2000	19.1764	367.7333	(10)
	N.	140.0000	18.5712	344.8889	(19)
	O.	139.5882	27.8345	774.7574	(17)
	Q.	151.4000	17.3858	302.2667	(10)
	R.	164.0000	0.0000	0.0000	(1)
	T.	168.3000	24.8408	617.0632	(20)
	U.	166.1500	32.6614	1066.7658	(20)
3.	N.	115.0000	29.6985	882.0000	(2)
	Q.	122.0000	0.0000	0.0000	(1)
4.	K.	205.6667	30.4357	926.3333	(3)
	L.	174.0000	20.4206	417.0000	(9)
	M.	216.2000	49.8267	2482.7000	(5)
	N.	157.8824	30.1867	911.2353	(17)
	O.	170.2000	43.3918	1882.8444	(10)
	P.	180.6667	14.7739	218.2667	(6)
	T.	198.7778	39.6541	1572.4444	(9)
	U.	151.3333	28.5015	812.3333	(3)
5.	L.	158.6000	13.7949	190.3000	(5)
	M.	141.2000	27.8001	772.8444	(10)
	O.	146.5000	33.6700	1133.6667	(4)
6.	G.	182.0000	10.9087	119.0000	(5)
	H.	163.6667	54.1233	2929.3333	(3)
	K.	198.0000	97.5807	9522.0000	(2)
	L.	174.5556	12.7780	163.2778	(9)
	M.	177.7000	27.9684	782.2333	(10)
	O.	167.8889	40.1947	1615.6111	(9)
	Q.	179.0000	48.2784	2330.8000	(6)
	R.	157.7500	30.4291	925.9286	(8)
	T.	176.4000	22.9739	527.8000	(5)
7.	R.	82.5294	11.4243	130.5147	(17)

Character C34 MLF Secondary Vein Angle

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	61.6364	4.7806	22.8545	(11)
	B.	59.7000	7.3643	54.2333	(10)
	C.	60.5000	5.2122	27.1667	(10)
	D.	60.8000	5.8271	33.9556	(10)
	E.	66.2632	8.2586	68.2047	(19)
	F.	65.5000	3.8944	15.1667	(10)
	G.	78.0000	8.4853	72.0000	(2)
	H.	62.6000	5.6214	31.6000	(10)
	I.	57.1000	5.9551	35.4632	(20)
	J.	57.5000	7.6468	58.4737	(20)
	K.	55.6000	5.5817	31.1556	(10)
	L.	64.5000	4.2308	17.9000	(6)
	M.	68.1667	3.8166	14.5667	(6)
	N.	67.6000	6.2442	38.9895	(20)
	O.	60.8750	4.7592	22.6500	(16)
	P.	63.6000	5.1251	26.2667	(10)
	Q.	66.6000	4.3512	18.9333	(10)
	R.	60.5385	9.7349	94.7692	(13)
	S.	65.2778	7.9986	63.9771	(18)
	T.	67.3500	5.9584	35.5026	(20)
	U.	62.6000	7.0442	49.6211	(20)
2.	M.	64.9000	6.7569	45.6556	(10)
	N.	69.5789	10.3726	107.5906	(19)
	O.	66.5882	6.1650	38.0074	(17)
	Q.	72.1000	5.1521	26.5444	(10)
	R.	71.0000	0.0000	0.0000	(1)
	T.	67.1500	4.8262	23.2921	(20)
	U.	66.3500	4.5222	20.4500	(20)
3.	N.	73.0000	5.6569	32.0000	(2)
	Q.	75.0000	0.0000	0.0000	(1)
4.	K.	60.3333	6.0277	36.3333	(3)
	L.	55.1111	4.3141	18.6111	(9)
	M.	47.2000	4.9699	24.7000	(5)
	N.	60.3529	9.1237	83.2426	(17)
	O.	54.9000	12.5649	157.8778	(10)
	P.	56.0000	8.0747	65.2000	(6)
	T.	63.2222	11.9350	142.4444	(9)
	U.	48.0000	9.8489	97.0000	(3)
5.	L.	45.0000	11.0000	121.0000	(5)
	M.	50.2000	8.4169	70.8444	(10)
	O.	49.7500	8.9954	80.9167	(4)
6.	G.	67.8000	5.6303	31.7000	(5)
	H.	71.0000	19.9750	399.0000	(3)
	K.	68.0000	9.8995	98.0000	(2)
	L.	58.2222	11.6809	136.4444	(9)
	M.	65.8000	7.6420	58.4000	(10)
	O.	62.3333	6.0828	37.0000	(9)
	Q.	61.3333	11.2012	125.4667	(6)
	R.	61.3750	6.6962	44.8393	(8)
	T.	65.6000	8.0187	64.3000	(5)
7.	R.	52.4118	6.4523	41.6324	(17)

Character C35 Capitulum Total Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	8.8909	0.6564	0.4309	(11)
	B.	9.4300	0.5755	0.3312	(10)
	C.	8.8300	0.3401	0.1157	(10)
	D.	9.3700	0.5736	0.3290	(10)
	E.	9.5526	0.2951	0.0871	(19)
	F.	9.3600	0.5038	0.2538	(10)
	G.	9.0500	0.0707	0.0050	(2)
	H.	9.0200	0.5712	0.3262	(10)
	I.	8.8700	0.8473	0.7180	(20)
	J.	9.1750	0.5839	0.3409	(20)
	K.	9.5300	0.8166	0.6668	(10)
	L.	9.1833	0.5845	0.3417	(6)
	M.	9.6833	1.1089	1.2297	(6)
	N.	10.2200	0.6598	0.4354	(20)
	O.	9.7688	0.4127	0.1703	(16)
	P.	9.5800	0.1932	0.0373	(10)
	Q.	9.6400	0.6168	0.3804	(10)
	R.	10.3769	0.4729	0.2236	(13)
	S.	9.6833	0.7725	0.5968	(18)
	T.	9.3550	0.7215	0.5205	(20)
	U.	9.3000	0.6951	0.4832	(20)
2.	M.	9.5100	0.6100	0.3721	(10)
	N.	10.2158	0.6577	0.4325	(19)
	O.	9.7529	0.5222	0.2726	(17)
	Q.	9.6000	0.5497	0.3022	(10)
	R.	10.5000	0.0000	0.0000	(1)
	T.	9.5050	0.7112	0.5058	(20)
	U.	8.9650	0.5687	0.3234	(20)
3.	N.	10.0000	0.4243	0.1800	(2)
	Q.	8.5000	0.0000	0.0000	(1)
4.	K.	14.1333	0.3055	0.0933	(3)
	L.	12.4667	0.7599	0.5775	(9)
	M.	13.2000	0.7746	0.6000	(5)
	N.	13.4882	0.6102	0.3724	(17)
	O.	13.6900	0.8306	0.6899	(10)
	P.	12.8167	0.9239	0.8537	(6)
	T.	13.1778	0.5890	0.3469	(9)
	U.	13.7000	0.8544	0.7300	(3)
5.	L.	11.8200	0.4658	0.2170	(5)
	M.	12.1100	1.1958	1.4299	(10)
	O.	13.1500	1.2069	1.4567	(4)
6.	G.	11.6200	0.6611	0.4370	(5)
	H.	12.5667	0.2517	0.0633	(3)
	K.	11.8500	1.3435	1.8050	(2)
	L.	12.0333	0.7794	0.6075	(9)
	M.	11.4200	0.5903	0.3484	(10)
	O.	11.7778	0.4549	0.2069	(9)
	Q.	11.6667	0.6377	0.4067	(6)
	R.	11.4500	0.5292	0.2800	(8)
	T.	11.5600	0.5273	0.2780	(5)
7.	R.	10.2882	0.4456	0.1986	(17)

Character C36 Capitulum Apex Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	4.2818	0.4729	0.2236	(11)
	B.	4.6300	0.3057	0.0934	(10)
	C.	4.5300	0.2214	0.0490	(10)
	D.	4.7700	0.6533	0.4268	(10)
	E.	4.4789	0.3630	0.1318	(19)
	F.	4.5000	0.3528	0.1244	(10)
	G.	4.2000	0.0000	0.0000	(2)
	H.	3.9700	0.3268	0.1068	(10)
	I.	4.2750	0.3447	0.1188	(20)
	J.	4.3200	0.2687	0.0722	(20)
	K.	4.5300	0.6378	0.4068	(10)
	L.	4.4667	0.8571	0.7347	(6)
	M.	3.8000	0.2280	0.0520	(6)
	N.	4.2150	0.3453	0.1192	(20)
	O.	4.1687	0.3381	0.1143	(16)
	P.	4.4800	0.2486	0.0618	(10)
	Q.	4.3100	0.5384	0.2899	(10)
	R.	4.8154	0.3870	0.1497	(13)
	S.	4.4333	0.4550	0.2071	(18)
	T.	4.2600	0.4828	0.2331	(20)
	U.	4.5100	0.3919	0.1536	(20)
2.	M.	3.9000	0.4714	0.2222	(10)
	N.	4.0053	0.3082	0.0950	(19)
	O.	4.1059	0.3269	0.1068	(17)
	Q.	4.1300	0.3164	0.1001	(10)
	R.	3.6000	0.0000	0.0000	(1)
	T.	4.2550	0.4261	0.1816	(20)
	U.	4.1900	0.2713	0.0736	(20)
3.	N.	4.3500	0.3536	0.1250	(2)
	Q.	4.0000	0.0000	0.0000	(1)
4.	K.	12.1667	2.6006	6.7633	(3)
	L.	8.2667	1.3444	1.8075	(9)
	M.	9.9800	0.9094	0.8270	(5)
	N.	9.8588	0.9906	0.9813	(17)
	O.	9.2000	0.5099	0.2600	(10)
	P.	10.3000	1.0714	1.1480	(6)
	T.	9.6778	0.9271	0.8594	(9)
	U.	9.6667	0.7506	0.5633	(3)
5.	L.	4.8200	0.4324	0.1870	(5)
	M.	5.3700	0.9370	0.8779	(10)
	O.	5.5500	0.4203	0.1767	(4)
6.	G.	4.8600	0.4506	0.2030	(5)
	H.	5.3000	0.7000	0.4900	(3)
	K.	4.9500	0.2121	0.0450	(2)
	L.	5.2556	0.2877	0.0828	(9)
	M.	4.7000	0.3055	0.0933	(10)
	O.	4.7333	0.2958	0.0875	(9)
	Q.	5.1000	0.5477	0.3000	(6)
	R.	4.7500	0.3964	0.1571	(8)
	T.	4.9400	0.2966	0.0880	(5)
7.	R.	3.3471	0.3338	0.1114	(17)

Character C37 Capitulum Base Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	3.9273	0.3797	0.1442	(11)
	B.	4.3700	0.3831	0.1468	(10)
	C.	4.1800	0.3190	0.1018	(10)
	D.	4.1700	0.3234	0.1046	(10)
	E.	4.0947	0.2656	0.0705	(19)
	F.	4.1500	0.2915	0.0850	(10)
	G.	3.6500	0.0707	0.0050	(2)
	H.	3.5000	0.1700	0.0289	(10)
	I.	3.9750	0.3143	0.0988	(20)
	J.	4.1550	0.3203	0.1026	(20)
	K.	4.0300	0.6093	0.3712	(10)
	L.	3.8333	0.2875	0.0827	(6)
	M.	3.9500	0.4764	0.2270	(6)
	N.	4.0550	0.3967	0.1573	(20)
	O.	4.1250	0.2887	0.0833	(16)
	P.	4.2200	0.2573	0.0662	(10)
	Q.	4.0300	0.4968	0.2468	(10)
	R.	4.4000	0.2915	0.0850	(13)
	S.	3.8889	0.5155	0.2658	(18)
	T.	3.8450	0.5605	0.3142	(20)
	U.	4.1000	0.3893	0.1516	(20)
2.	M.	3.8400	0.3471	0.1204	(10)
	N.	3.9526	0.2970	0.0882	(19)
	O.	3.9412	0.4124	0.1701	(17)
	Q.	3.9100	0.3814	0.1454	(10)
	R.	3.8000	0.0000	0.0000	(1)
	T.	3.7000	0.4155	0.1726	(20)
	U.	3.6550	0.3332	0.1110	(20)
3.	N.	3.8500	0.4950	0.2450	(2)
	Q.	3.4000	0.0000	0.0000	(1)
4.	K.	6.9667	1.1590	1.3433	(3)
	L.	5.4889	0.4428	0.1961	(9)
	M.	5.5400	0.2881	0.0830	(5)
	N.	5.7765	0.5118	0.2619	(17)
	O.	5.8800	0.3155	0.0996	(10)
	P.	5.5167	0.5345	0.2857	(6)
	T.	5.5000	0.3708	0.1375	(9)
	U.	6.3000	0.4359	0.1900	(3)
5.	L.	4.7800	0.3421	0.1170	(5)
	M.	4.9600	0.7183	0.5160	(10)
	O.	5.1250	0.2062	0.0425	(4)
6.	G.	4.7200	0.2775	0.0770	(5)
	H.	5.0000	0.5292	0.2800	(3)
	K.	5.0500	0.4950	0.2450	(2)
	L.	5.0778	0.2108	0.0444	(9)
	M.	4.7800	0.3084	0.0951	(10)
	O.	4.5444	0.2789	0.0778	(9)
	Q.	4.9500	0.2074	0.0430	(6)
	R.	4.7875	0.3137	0.0984	(8)
	T.	4.8600	0.1817	0.0330	(5)
7.	R.	3.5588	0.1906	0.0363	(17)

Character C38 Pedicel Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	2.8000	1.3506	1.8240	(11)
	B.	2.3700	1.0023	1.0046	(10)
	C.	2.6300	1.5326	2.3490	(10)
	D.	3.6600	1.6440	2.7027	(10)
	E.	3.2737	1.9689	3.8765	(19)
	F.	2.8300	1.3483	1.8179	(10)
	G.	5.7000	2.9698	8.8200	(2)
	H.	3.9400	1.4455	2.0893	(10)
	I.	2.9350	1.4409	2.0761	(20)
	J.	2.8550	1.7641	3.1121	(20)
	K.	4.6000	2.0177	4.0711	(10)
	L.	3.4167	1.1686	1.3657	(6)
	M.	5.1500	1.9736	3.8950	(6)
	N.	5.8900	2.3682	5.6083	(20)
	O.	3.1437	1.6436	2.7013	(16)
	P.	3.0400	1.6105	2.5938	(10)
	Q.	5.9500	2.0294	4.1183	(10)
	R.	6.9846	2.8041	7.8631	(13)
	S.	3.0889	1.8572	3.4493	(18)
	T.	2.9850	1.7458	3.0477	(20)
	U.	3.2600	1.4095	1.9867	(20)
2.	M.	4.0600	1.3986	1.9560	(10)
	N.	4.6526	2.4901	6.2004	(19)
	O.	3.3176	1.5505	2.4040	(17)
	Q.	3.6200	2.3342	5.4484	(10)
	R.	6.6000	0.0000	0.0000	(1)
	T.	3.6900	2.0308	4.1241	(20)
	U.	2.9750	1.6386	2.6851	(20)
3.	N.	4.2000	0.2828	0.0800	(2)
	Q.	5.0000	0.0000	0.0000	(1)
4.	K.	22.2667	11.1096	123.4233	(3)
	L.	16.9778	6.6727	44.5244	(9)
	M.	15.3000	2.0050	4.0200	(5)
	N.	14.6059	7.1224	50.7281	(17)
	O.	16.1200	6.1002	37.2129	(10)
	P.	14.9667	8.4258	70.9947	(6)
	T.	15.5667	7.2677	52.8200	(9)
	U.	17.5667	3.6937	13.6433	(3)
5.	L.	11.2800	3.8480	14.8070	(5)
	M.	11.5400	4.2942	18.4404	(10)
	O.	11.3750	6.6685	44.4692	(4)
6.	G.	13.4800	3.4164	11.6720	(5)
	H.	18.6667	8.1617	66.6133	(3)
	K.	14.6000	6.7882	46.0800	(2)
	L.	13.1222	3.8330	14.6919	(9)
	M.	12.4200	4.1222	16.9929	(10)
	O.	12.4444	4.3408	18.8428	(9)
	Q.	15.7833	6.5670	43.1257	(6)
	R.	16.8750	5.7276	32.8050	(8)
	T.	14.3000	5.8159	33.8250	(5)
7.	R.	7.4824	3.0869	9.5290	(17)

Character C39 Number Of Phyllaries

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	20.3636	2.4606	6.0545	(11)
	B.	21.0000	0.0000	0.0000	(10)
	C.	21.0000	0.0000	0.0000	(10)
	D.	20.8000	0.6325	0.4000	(10)
	E.	20.4737	1.6455	2.7076	(19)
	F.	20.4000	1.8974	3.6000	(10)
	G.	21.0000	0.0000	0.0000	(2)
	H.	19.7000	1.7670	3.1222	(10)
	I.	21.0000	0.0000	0.0000	(20)
	J.	21.0000	0.3244	0.1053	(20)
	K.	20.6000	0.9661	0.9333	(10)
	L.	20.6667	0.8165	0.6667	(6)
	M.	19.5000	2.0736	4.3000	(6)
	N.	20.5000	1.3572	1.8421	(20)
	O.	20.7500	1.0000	1.0000	(16)
	P.	21.0000	0.0000	0.0000	(10)
	Q.	20.4000	1.7127	2.9333	(10)
	R.	21.0769	0.2774	0.0769	(13)
	S.	20.1111	1.9369	3.7516	(18)
	T.	20.5500	1.0990	1.2079	(20)
	U.	20.9500	0.2236	0.0500	(20)
2.	M.	20.6000	0.9661	0.9333	(10)
	N.	20.9474	0.2294	0.0526	(19)
	O.	20.9412	0.2425	0.0588	(17)
	Q.	20.8000	0.4216	0.1778	(10)
	R.	18.0000	0.0000	0.0000	(1)
	T.	20.1500	1.8715	3.5026	(20)
	U.	20.7000	0.8013	0.6421	(20)
3.	N.	22.0000	1.4142	2.0000	(2)
	Q.	19.0000	0.0000	0.0000	(1)
4.	K.	23.0000	2.0000	4.0000	(3)
	L.	21.3333	0.5000	0.2500	(9)
	M.	21.0000	0.7071	0.5000	(5)
	N.	21.0000	0.3536	0.1250	(17)
	O.	21.0000	0.0000	0.0000	(10)
	P.	20.8333	1.3292	1.7667	(6)
	T.	21.0000	0.0000	0.0000	(9)
	U.	21.0000	0.0000	0.0000	(3)
5.	L.	21.0000	0.0000	0.0000	(5)
	M.	18.5000	3.4721	12.0556	(10)
	O.	21.0000	0.0000	0.0000	(4)
6.	G.	21.0000	0.0000	0.0000	(5)
	H.	20.0000	1.7321	3.0000	(3)
	K.	21.0000	0.0000	0.0000	(2)
	L.	21.0000	0.0000	0.0000	(9)
	M.	21.0000	0.0000	0.0000	(10)
	O.	21.0000	0.0000	0.0000	(9)
	Q.	21.0000	0.0000	0.0000	(6)
	R.	20.8750	0.3536	0.1250	(8)
	T.	21.0000	0.0000	0.0000	(5)
7.	R.	16.8235	1.6672	2.7794	(17)

Character C40 Max Phyllary Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	6.0727	0.2611	0.0682	(11)
	B.	6.0200	0.2936	0.0862	(10)
	C.	6.0600	0.3098	0.0960	(10)
	D.	5.9900	0.3542	0.1254	(10)
	E.	6.6368	0.5101	0.2602	(19)
	F.	6.4000	0.4595	0.2111	(10)
	G.	6.2500	0.4950	0.2450	(2)
	H.	6.0500	0.2369	0.0561	(10)
	I.	5.8000	0.3509	0.1232	(20)
	J.	5.9600	0.4512	0.2036	(20)
	K.	6.5800	0.2616	0.0684	(10)
	L.	6.5333	0.2944	0.0867	(6)
	M.	7.3500	0.3017	0.0910	(6)
	N.	7.3450	0.3103	0.0963	(20)
	O.	6.9750	0.3493	0.1220	(16)
	P.	6.6000	0.1700	0.0289	(10)
	Q.	6.5800	0.4517	0.2040	(10)
	R.	7.4000	0.5000	0.2500	(13)
	S.	6.7056	0.5150	0.2653	(18)
	T.	6.4300	0.3922	0.1538	(20)
	U.	6.3400	0.4285	0.1836	(20)
2.	M.	6.5400	0.3026	0.0916	(10)
	N.	7.0421	0.3421	0.1170	(19)
	O.	6.7000	0.3640	0.1325	(17)
	Q.	6.8000	0.3232	0.1044	(10)
	R.	7.2000	0.0000	0.0000	(1)
	T.	6.4300	0.2408	0.0580	(20)
	U.	6.1900	0.3007	0.0904	(20)
3.	N.	7.2500	0.4950	0.2450	(2)
	Q.	6.4000	0.0000	0.0000	(1)
4.	K.	6.5667	0.5508	0.3033	(3)
	L.	6.1333	0.2693	0.0725	(9)
	M.	6.1200	0.3834	0.1470	(5)
	N.	6.6353	0.3622	0.1312	(17)
	O.	6.4800	0.3882	0.1507	(10)
	P.	6.2667	0.2733	0.0747	(6)
	T.	6.3556	0.3358	0.1128	(9)
	U.	6.3000	0.3000	0.0900	(3)
5.	L.	7.0200	0.3347	0.1120	(5)
	M.	6.9400	0.5602	0.3138	(10)
	O.	7.2250	0.3862	0.1492	(4)
6.	G.	7.3400	0.6025	0.3630	(5)
	H.	7.6667	0.1155	0.0133	(3)
	K.	7.2500	0.4950	0.2450	(2)
	L.	7.4556	0.2833	0.0803	(9)
	M.	7.2100	0.3143	0.0988	(10)
	O.	7.2444	0.3844	0.1478	(9)
	Q.	7.4167	0.3061	0.0937	(6)
	R.	7.3500	0.3546	0.1257	(8)
	T.	7.2800	0.4970	0.2470	(5)
7.	R.	7.2882	0.3389	0.1149	(17)

Character C44 Number Of Calyculus Bracts

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	15.8182	3.0925	9.5636	(11)
	B.	18.1000	2.4698	6.1000	(10)
	C.	15.9000	1.6633	2.7667	(10)
	D.	15.6000	1.7127	2.9333	(10)
	E.	14.5789	2.5015	6.2573	(19)
	F.	16.9000	2.9231	8.5444	(10)
	G.	19.5000	3.5355	12.5000	(2)
	H.	16.5000	2.1213	4.5000	(10)
	I.	16.3000	1.7502	3.0632	(20)
	J.	16.4000	1.6670	2.7789	(20)
	K.	12.9000	2.4698	6.1000	(10)
	L.	12.5000	1.0488	1.1000	(6)
	M.	13.1667	1.9408	3.7667	(6)
	N.	13.3000	2.6970	7.2737	(20)
	O.	14.2500	2.8166	7.9333	(16)
	P.	13.4000	2.2211	4.9333	(10)
	Q.	17.3000	4.8546	23.5667	(10)
	R.	15.9231	4.6451	21.5769	(13)
	S.	12.7778	2.1020	4.4183	(18)
	T.	14.7000	2.4942	6.2211	(20)
	U.	15.8500	2.4979	6.2395	(20)
2.	M.	14.0000	1.0541	1.1111	(10)
	N.	15.0000	1.7321	3.0000	(19)
	O.	15.0000	1.7321	3.0000	(17)
	Q.	15.2000	1.8738	3.5111	(10)
	R.	13.0000	0.0000	0.0000	(1)
	T.	17.5000	2.6258	6.8947	(20)
	U.	15.9000	3.6404	13.2526	(20)
3.	N.	20.0000	0.0000	0.0000	(2)
	Q.	20.0000	0.0000	0.0000	(1)
4.	K.	10.3333	3.2146	10.3333	(3)
	L.	13.0000	1.5811	2.5000	(9)
	M.	7.4000	1.1402	1.3000	(5)
	N.	10.4706	2.4010	5.7647	(17)
	O.	10.6000	1.8974	3.6000	(10)
	P.	10.5000	1.3784	1.9000	(6)
	T.	10.6667	1.5811	2.5000	(9)
	U.	10.3333	1.5275	2.3333	(3)
5.	L.	7.4000	1.1402	1.3000	(5)
	M.	5.5000	0.8498	0.7222	(10)
	O.	6.2500	0.9574	0.9167	(4)
6.	G.	5.0000	0.7071	0.5000	(5)
	H.	4.3333	0.5774	0.3333	(3)
	K.	4.5000	0.7071	0.5000	(2)
	L.	4.7778	0.4410	0.1944	(9)
	M.	4.9000	0.5676	0.3222	(10)
	O.	4.6667	0.8660	0.7500	(9)
	Q.	4.8333	0.7528	0.5667	(6)
	R.	5.0000	0.5345	0.2857	(8)
	T.	5.0000	0.7071	0.5000	(5)
7.	R.	3.8235	0.5286	0.2794	(17)

Character C45 Number Of Pedicel Bracts

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	1.0000	0.6325	0.4000	(11)
	B.	1.5000	0.5270	0.2778	(10)
	C.	1.7000	0.9487	0.9000	(10)
	D.	1.5000	0.7071	0.5000	(10)
	E.	1.4737	0.5130	0.2632	(19)
	F.	1.1000	0.8756	0.7667	(10)
	G.	2.0000	1.4142	2.0000	(2)
	H.	1.6000	0.9661	0.9333	(10)
	I.	1.4500	0.8256	0.6816	(20)
	J.	1.2000	0.8335	0.6947	(20)
	K.	1.0000	0.8165	0.6667	(10)
	L.	1.5000	1.0488	1.1000	(6)
	M.	1.5000	0.8367	0.7000	(6)
	N.	0.7000	0.5712	0.3263	(20)
	O.	1.2500	0.9309	0.8667	(16)
	P.	1.6000	0.8433	0.7111	(10)
	Q.	1.4000	0.6992	0.4889	(10)
	R.	1.4615	0.8771	0.7692	(13)
	S.	1.5000	0.7859	0.6176	(18)
	T.	1.5000	0.7609	0.5789	(20)
	U.	1.5500	0.6863	0.4711	(20)
2.	M.	1.3000	1.1595	1.3444	(10)
	N.	1.0000	0.8819	0.7778	(19)
	O.	1.3529	0.7859	0.6176	(17)
	Q.	0.9000	0.5676	0.3222	(10)
	R.	1.0000	0.0000	0.0000	(1)
	T.	1.5500	0.9445	0.8921	(20)
	U.	1.8500	0.8751	0.7658	(20)
3.	N.	1.5000	0.7071	0.5000	(2)
	Q.	2.0000	0.0000	0.0000	(1)
4.	K.	4.0000	1.0000	1.0000	(3)
	L.	4.5556	2.1858	4.7778	(9)
	M.	1.2000	1.0954	1.2000	(5)
	N.	3.6471	2.4985	6.2426	(17)
	O.	2.6000	0.9661	0.9333	(10)
	P.	3.6667	1.2111	1.4667	(6)
	T.	4.0000	2.7839	7.7500	(9)
	U.	1.6667	0.5774	0.3333	(3)
5.	L.	2.4000	0.5477	0.3000	(5)
	M.	2.7000	0.9487	0.9000	(10)
	O.	2.7500	0.5000	0.2500	(4)
6.	G.	2.0000	0.7071	0.5000	(5)
	H.	2.6667	0.5774	0.3333	(3)
	K.	2.5000	0.7071	0.5000	(2)
	L.	2.2222	0.8333	0.6944	(9)
	M.	2.3000	0.6749	0.4556	(10)
	O.	1.8889	0.7817	0.6111	(9)
	Q.	2.0000	0.6325	0.4000	(6)
	R.	2.1250	0.6409	0.4107	(8)
	T.	2.0000	0.7071	0.5000	(5)
7.	R.	2.1765	0.6359	0.4044	(17)

Character C48 Mean Calyculus Bract Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	1.9518	0.2153	0.0463	(11)
	B.	1.8830	0.1083	0.0117	(10)
	C.	1.7480	0.0915	0.0084	(10)
	D.	1.8110	0.0700	0.0049	(10)
	E.	2.5063	0.0687	0.0047	(19)
	F.	1.9660	0.2092	0.0438	(10)
	G.	2.0900	0.1556	0.0242	(2)
	H.	1.7330	0.1503	0.0226	(10)
	I.	2.0300	0.1134	0.0129	(20)
	J.	2.0095	0.0964	0.0093	(20)
	K.	2.1620	0.1014	0.0103	(10)
	L.	2.2983	0.1463	0.0214	(6)
	M.	2.3667	0.1726	0.0298	(6)
	N.	2.4025	0.1936	0.0375	(20)
	O.	2.2662	0.2082	0.0433	(16)
	P.	2.3570	0.2863	0.0820	(10)
	Q.	2.0800	0.3543	0.1255	(10)
	R.	2.6815	0.3283	0.1078	(13)
	S.	2.4350	0.3694	0.1364	(18)
	T.	1.9430	0.1806	0.0326	(20)
	U.	1.9690	0.2008	0.0403	(20)
2.	M.	1.9210	0.0882	0.0078	(10)
	N.	2.0874	0.3042	0.0926	(19)
	O.	1.9818	0.1428	0.0204	(17)
	Q.	2.0300	0.1903	0.0362	(10)
	R.	2.0500	0.0000	0.0000	(1)
	T.	1.8785	0.1659	0.0275	(20)
	U.	1.8165	0.1779	0.0316	(20)
3.	N.	2.2550	0.0354	0.0012	(2)
	Q.	1.9800	0.0000	0.0000	(1)
4.	K.	2.5733	0.3172	0.1006	(3)
	L.	2.5344	0.2472	0.0611	(9)
	M.	3.1260	0.3945	0.1556	(5)
	N.	3.0812	0.3793	0.1439	(17)
	O.	3.0830	0.5343	0.2855	(10)
	P.	2.5367	0.1661	0.0276	(6)
	T.	2.7644	0.3425	0.1173	(9)
	U.	2.9933	0.1976	0.0390	(3)
5.	L.	3.6320	0.4305	0.1854	(5)
	M.	3.5920	0.4247	0.1804	(10)
	O.	3.3600	0.3273	0.1071	(4)
6.	G.	5.6160	0.5586	0.3121	(5)
	H.	5.3300	0.7353	0.5407	(3)
	K.	5.2000	0.4384	0.1922	(2)
	L.	5.4956	0.7360	0.5417	(9)
	M.	5.4320	0.3795	0.1440	(10)
	O.	5.7156	0.6496	0.4219	(9)
	Q.	5.6150	0.4599	0.2115	(6)
	R.	5.5950	0.4044	0.1635	(8)
	T.	5.5960	0.5163	0.2666	(5)
7.	R.	2.2229	0.2351	0.0553	(17)

Character C49 Range Calyculus Bract Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	1.1364	0.5464	0.2985	(11)
	B.	0.9100	0.1792	0.0321	(10)
	C.	0.9100	0.2685	0.0721	(10)
	D.	0.9100	0.2424	0.0588	(10)
	E.	0.9579	0.2009	0.0404	(19)
	F.	0.9400	0.3565	0.1271	(10)
	G.	1.4000	0.9899	0.9800	(2)
	H.	0.8200	0.1476	0.0218	(10)
	I.	0.9600	0.1818	0.0331	(20)
	J.	1.1100	0.4610	0.2125	(20)
	K.	1.1200	0.4638	0.2151	(10)
	L.	1.0500	0.1871	0.0350	(6)
	M.	1.5167	0.9042	0.8177	(6)
	N.	1.5400	0.8905	0.7931	(20)
	O.	1.3250	0.6465	0.4180	(16)
	P.	1.3600	0.5481	0.3004	(10)
	Q.	1.7200	1.0097	1.0196	(10)
	R.	1.2538	0.7310	0.5344	(13)
	S.	0.9333	0.3361	0.1129	(18)
	T.	1.0400	0.2854	0.0815	(20)
	U.	1.0900	0.4424	0.1957	(20)
2.	M.	1.1100	0.2846	0.0810	(10)
	N.	1.2526	0.6475	0.4193	(19)
	O.	1.1294	0.5429	0.2947	(17)
	Q.	1.5100	0.4909	0.2410	(10)
	R.	0.9000	0.0000	0.0000	(1)
	T.	0.8300	0.2452	0.0601	(20)
	U.	0.6550	0.2328	0.0542	(20)
3.	N.	0.8500	0.4950	0.2450	(2)
	Q.	1.3000	0.0000	0.0000	(1)
4.	K.	0.8000	0.4000	0.1600	(3)
	L.	0.8444	0.2128	0.0453	(9)
	M.	1.1400	0.6066	0.3680	(5)
	N.	1.1353	0.5454	0.2974	(17)
	O.	0.9400	0.4648	0.2160	(10)
	P.	1.0833	0.3869	0.1497	(6)
	T.	0.8111	0.2421	0.0586	(9)
	U.	1.1000	0.2646	0.0700	(3)
5.	L.	1.2600	0.7635	0.5830	(5)
	M.	0.7200	0.3584	0.1284	(10)
	O.	0.8750	0.4425	0.1958	(4)
6.	G.	0.8000	0.3536	0.1250	(5)
	H.	0.7000	0.3606	0.1300	(3)
	K.	0.7000	0.2828	0.0800	(2)
	L.	1.1333	0.5723	0.3275	(9)
	M.	1.1900	0.3247	0.1054	(10)
	O.	1.0222	0.4055	0.1644	(9)
	Q.	1.2000	0.5099	0.2600	(6)
	R.	1.1500	0.5155	0.2657	(8)
	T.	1.0600	0.6348	0.4030	(5)
7.	R.	0.5235	0.1821	0.0332	(17)

Character C50 Mean Calyculus Bract Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	0.6636	0.0757	0.0057	(11)
	B.	0.6590	0.0590	0.0035	(10)
	C.	0.6080	0.0358	0.0013	(10)
	D.	0.6370	0.0400	0.0016	(10)
	E.	0.5589	0.0346	0.0012	(19)
	F.	0.6460	0.0453	0.0020	(10)
	G.	0.6050	0.0071	0.0000	(2)
	H.	0.5580	0.0346	0.0012	(10)
	I.	0.6570	0.0370	0.0014	(20)
	J.	0.6605	0.0352	0.0012	(20)
	K.	0.7430	0.0701	0.0049	(10)
	L.	0.6400	0.0405	0.0016	(6)
	M.	0.7233	0.0547	0.0030	(6)
	N.	0.6680	0.0655	0.0043	(20)
	O.	0.7163	0.0749	0.0056	(16)
	P.	0.7500	0.0591	0.0035	(10)
	Q.	0.6420	0.0857	0.0074	(10)
	R.	0.7162	0.0796	0.0063	(13)
	S.	0.6117	0.0877	0.0077	(18)
	T.	0.6445	0.0445	0.0020	(20)
	U.	0.6530	0.0484	0.0023	(20)
2.	M.	0.6390	0.0536	0.0029	(10)
	N.	0.6632	0.0392	0.0015	(19)
	O.	0.6435	0.0500	0.0025	(17)
	Q.	0.6260	0.0481	0.0023	(10)
	R.	0.6700	0.0000	0.0000	(1)
	T.	0.6630	0.0336	0.0011	(20)
	U.	0.6665	0.2090	0.0437	(20)
3.	N.	0.6000	0.0424	0.0018	(2)
	Q.	0.6400	0.0000	0.0000	(1)
4.	K.	0.7933	0.0777	0.0060	(3)
	L.	0.6167	0.1025	0.0105	(9)
	M.	0.7540	0.1841	0.0339	(5)
	N.	0.6953	0.1086	0.0118	(17)
	O.	0.6720	0.0903	0.0082	(10)
	P.	0.6400	0.1217	0.0148	(6)
	T.	0.6533	0.0532	0.0028	(9)
	U.	0.7400	0.0781	0.0061	(3)
5.	L.	0.5680	0.0823	0.0068	(5)
	M.	0.6500	0.1495	0.0224	(10)
	O.	0.6125	0.0222	0.0005	(4)
6.	G.	0.5720	0.0370	0.0014	(5)
	H.	0.5767	0.0493	0.0024	(3)
	K.	0.5450	0.0354	0.0013	(2)
	L.	0.5100	0.0482	0.0023	(9)
	M.	0.5330	0.0422	0.0018	(10)
	O.	0.5444	0.0527	0.0028	(9)
	Q.	0.5483	0.0741	0.0055	(6)
	R.	0.5437	0.0619	0.0038	(8)
	T.	0.5440	0.0451	0.0020	(5)
7.	R.	0.4253	0.0339	0.0012	(17)

Character C51 Calyculus Bract Black Tip Max Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	1.3682	0.2065	0.0426	(11)
	B.	1.3250	0.0425	0.0018	(10)
	C.	1.2050	0.1212	0.0147	(10)
	D.	1.1750	0.0858	0.0074	(10)
	E.	1.7474	0.0589	0.0035	(19)
	F.	1.6050	0.2432	0.0591	(10)
	G.	0.7750	0.1768	0.0313	(2)
	H.	1.2100	0.0907	0.0082	(10)
	I.	1.2500	0.1414	0.0200	(20)
	J.	1.3000	0.0607	0.0037	(20)
	K.	1.4700	0.1567	0.0246	(10)
	L.	1.5917	0.0376	0.0014	(6)
	M.	1.2583	0.1320	0.0174	(6)
	N.	1.1425	0.2238	0.0501	(20)
	O.	1.3531	0.2125	0.0452	(16)
	P.	1.4700	0.0537	0.0029	(10)
	Q.	0.9150	0.2427	0.0589	(10)
	R.	1.2038	0.2203	0.0485	(13)
	S.	1.3861	0.4158	0.1729	(18)
	T.	1.0400	0.2043	0.0417	(20)
	U.	1.1950	0.2133	0.0455	(20)
2.	M.	1.5350	0.1375	0.0189	(10)
	N.	1.1395	0.2325	0.0540	(19)
	O.	1.5500	0.2669	0.0713	(17)
	Q.	1.4650	0.1944	0.0378	(10)
	R.	1.5500	0.0000	0.0000	(1)
	T.	1.4250	0.1198	0.0143	(20)
	U.	1.5150	0.1319	0.0174	(20)
3.	N.	1.1000	0.2121	0.0450	(2)
	Q.	0.9500	0.0000	0.0000	(1)
4.	K.	1.0667	0.2930	0.0858	(3)
	L.	0.7889	0.1364	0.0186	(9)
	M.	0.9900	0.0962	0.0092	(5)
	N.	0.9559	0.2249	0.0506	(17)
	O.	0.9600	0.2777	0.0771	(10)
	P.	0.8417	0.0585	0.0034	(6)
	T.	0.9111	0.1318	0.0174	(9)
	U.	0.8333	0.0764	0.0058	(3)
5.	L.	0.8000	0.2622	0.0688	(5)
	M.	0.7900	0.1647	0.0271	(10)
	O.	0.9250	0.0645	0.0042	(4)
6.	G.	0.5800	0.0447	0.0020	(5)
	H.	0.5000	0.0500	0.0025	(3)
	K.	0.5750	0.0354	0.0013	(2)
	L.	0.5944	0.0846	0.0072	(9)
	M.	0.5800	0.0587	0.0034	(10)
	O.	0.6722	0.1093	0.0119	(9)
	Q.	0.5250	0.0689	0.0048	(6)
	R.	0.5375	0.0835	0.0070	(8)
	T.	0.5300	0.0274	0.0008	(5)
7.	R.	0.0000	0.0000	0.0000	(17)

Character C52 Calyculus Bract Black Tip Max Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	0.6818	0.0783	0.0061	(11)
	B.	0.6650	0.0580	0.0034	(10)
	C.	0.6100	0.0568	0.0032	(10)
	D.	0.6250	0.0425	0.0018	(10)
	E.	0.6763	0.0452	0.0020	(19)
	F.	0.6450	0.0762	0.0058	(10)
	G.	0.4000	0.0707	0.0050	(2)
	H.	0.6350	0.0337	0.0011	(10)
	I.	0.6575	0.0520	0.0027	(20)
	J.	0.6350	0.0516	0.0027	(20)
	K.	0.7100	0.0658	0.0043	(10)
	L.	0.4667	0.0408	0.0017	(6)
	M.	0.5667	0.1663	0.0277	(6)
	N.	0.5225	0.2215	0.0491	(20)
	O.	0.6063	0.1109	0.0123	(16)
	P.	0.4600	0.0516	0.0027	(10)
	Q.	0.5000	0.1599	0.0256	(10)
	R.	0.5615	0.0893	0.0080	(13)
	S.	0.4583	0.1115	0.0124	(18)
	T.	0.5325	0.0634	0.0040	(20)
	U.	0.5500	0.1039	0.0108	(20)
2.	M.	0.6550	0.1423	0.0202	(10)
	N.	0.5263	0.0562	0.0032	(19)
	O.	0.6541	0.1048	0.0110	(17)
	Q.	0.6300	0.0888	0.0079	(10)
	R.	0.6500	0.0000	0.0000	(1)
	T.	0.6300	0.0377	0.0014	(20)
	U.	0.6375	0.0393	0.0015	(20)
3.	N.	0.3750	0.0354	0.0013	(2)
	Q.	0.3500	0.0000	0.0000	(1)
4.	K.	0.5667	0.0764	0.0058	(3)
	L.	0.3944	0.0300	0.0009	(9)
	M.	0.5500	0.0935	0.0087	(5)
	N.	0.4235	0.0773	0.0060	(17)
	O.	0.4000	0.0624	0.0039	(10)
	P.	0.4417	0.0736	0.0054	(6)
	T.	0.4000	0.0559	0.0031	(9)
	U.	0.3667	0.0289	0.0008	(3)
5.	L.	0.3400	0.0418	0.0017	(5)
	M.	0.3350	0.1107	0.0123	(10)
	O.	0.3250	0.0289	0.0008	(4)
6.	G.	0.2800	0.0447	0.0020	(5)
	H.	0.2167	0.0289	0.0008	(3)
	K.	0.2250	0.0354	0.0012	(2)
	L.	0.2167	0.0433	0.0019	(9)
	M.	0.2650	0.0337	0.0011	(10)
	O.	0.2889	0.0486	0.0024	(9)
	Q.	0.7500	1.1036	1.2180	(6)
	R.	0.2563	0.0563	0.0032	(8)
	T.	0.2700	0.0274	0.0008	(5)
7.	R.	0.0000	0.0000	0.0000	(17)

Character C53 Number Of Disc Florets

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	71.2727	13.3723	178.8182	(11)
	B.	82.2000	11.2527	126.6222	(10)
	C.	74.7000	7.8606	61.7889	(10)
	D.	67.0000	10.5198	110.6667	(10)
	E.	66.7368	9.6715	93.5380	(19)
	F.	66.2000	10.0421	100.8444	(10)
	G.	65.5000	6.3640	40.5000	(2)
	H.	51.2000	6.8118	46.4000	(10)
	I.	64.4500	9.3723	87.8395	(20)
	J.	67.4500	9.5116	90.4711	(20)
	K.	62.4000	19.9009	396.0444	(10)
	L.	59.6667	10.1915	103.8667	(6)
	M.	55.1667	7.6790	58.9667	(6)
	N.	53.7000	9.2287	85.1684	(20)
	O.	53.0000	10.4626	109.4667	(16)
	P.	61.6000	8.0994	65.6000	(10)
	Q.	59.5000	10.0802	101.6111	(10)
	R.	62.4615	8.1098	65.7692	(13)
	S.	57.5000	6.5011	42.2647	(18)
	T.	53.9500	11.5780	134.0500	(20)
	U.	69.8000	7.4805	55.9579	(20)
2.	M.	49.6000	8.2758	68.4889	(10)
	N.	46.7895	4.7677	22.7310	(19)
	O.	49.8824	7.5240	56.6103	(17)
	Q.	50.0000	2.7889	7.7778	(10)
	R.	45.0000	0.0000	0.0000	(1)
	T.	45.7500	5.3299	28.4079	(20)
	U.	57.1500	6.1753	38.1342	(20)
3.	N.	60.0000	12.7279	162.0000	(2)
	Q.	48.0000	0.0000	0.0000	(1)
4.	K.	122.6667	12.6623	160.3333	(3)
	L.	86.2222	15.6507	244.9444	(9)
	M.	97.4000	10.3586	107.3000	(5)
	N.	86.4706	16.4245	269.7647	(17)
	O.	96.2000	12.7174	161.7333	(10)
	P.	90.6667	14.8414	220.2667	(6)
	T.	93.4444	7.7154	59.5278	(9)
	U.	99.6667	12.2202	149.3333	(3)
5.	L.	63.8000	10.9636	120.2000	(5)
	M.	51.4000	11.7587	138.2667	(10)
	O.	57.5000	5.0000	25.0000	(4)
6.	G.	61.4000	6.1887	38.3000	(5)
	H.	63.6667	17.2143	296.3333	(3)
	K.	67.5000	9.1924	84.5000	(2)
	L.	67.3333	8.9303	79.7500	(9)
	M.	58.4000	7.2142	52.0444	(10)
	O.	59.2222	9.9093	98.1944	(9)
	Q.	61.6667	7.0333	49.4667	(6)
	R.	58.3750	8.3141	69.1250	(8)
	T.	58.2000	7.1204	50.7000	(5)
7.	R.	51.5882	4.3020	18.5074	(17)

Character C54 Mean Disc Floret Total Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	6.5118	0.4710	0.2218	(11)
	B.	6.6310	0.2078	0.0432	(10)
	C.	6.4430	0.3109	0.0966	(10)
	D.	6.6890	0.2288	0.0524	(10)
	E.	6.6379	0.1868	0.0349	(19)
	F.	6.7310	0.2656	0.0705	(10)
	G.	6.5650	0.1344	0.0181	(2)
	H.	6.6150	0.1893	0.0358	(10)
	I.	6.1465	0.3521	0.1239	(20)
	J.	6.3920	0.2716	0.0738	(20)
	K.	7.1240	0.5590	0.3124	(10)
	L.	6.9167	0.3163	0.1001	(6)
	M.	7.6433	0.7334	0.5379	(6)
	N.	7.6065	0.3962	0.1570	(20)
	O.	7.2562	0.4160	0.1730	(16)
	P.	7.0890	0.5039	0.2539	(10)
	Q.	7.0180	0.5379	0.2894	(10)
	R.	7.5308	0.5093	0.2594	(13)
	S.	6.8906	0.4797	0.2301	(18)
	T.	6.5035	0.3545	0.1257	(20)
	U.	6.5025	0.3124	0.0976	(20)
2.	M.	7.1010	0.3704	0.1372	(10)
	N.	7.4716	0.5437	0.2956	(19)
	O.	7.1347	0.5618	0.3156	(17)
	Q.	6.8660	0.3998	0.1598	(10)
	R.	7.4900	0.0000	0.0000	(1)
	T.	6.8480	0.4812	0.2316	(20)
	U.	6.3070	0.3295	0.1085	(20)
3.	N.	6.6450	0.5586	0.3120	(2)
	Q.	5.9700	0.0000	0.0000	(1)
4.	K.	9.6033	0.7794	0.6074	(3)
	L.	8.9578	0.5667	0.3211	(9)
	M.	8.9660	0.7571	0.5732	(5)
	N.	8.6882	0.5697	0.3246	(17)
	O.	8.7630	0.3248	0.1055	(10)
	P.	8.6167	0.4663	0.2174	(6)
	T.	8.5989	0.7373	0.5436	(9)
	U.	8.7433	0.7601	0.5777	(3)
5.	L.	8.6040	0.2558	0.0654	(5)
	M.	8.6230	0.4883	0.2385	(10)
	O.	8.9300	0.4967	0.2467	(4)
6.	G.	8.5600	0.7926	0.6282	(5)
	H.	9.0167	0.3581	0.1282	(3)
	K.	8.8900	0.3394	0.1152	(2)
	L.	8.2978	0.3681	0.1355	(9)
	M.	8.2610	0.3120	0.0973	(10)
	O.	8.3022	0.3004	0.0902	(9)
	Q.	8.0550	0.2966	0.0879	(6)
	R.	8.1687	0.3196	0.1021	(8)
	T.	8.3140	0.2948	0.0869	(5)
7.	R.	7.5941	0.2851	0.0813	(17)

Character C55 Mean Disc Floret Corolla Tube Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	1.8782	0.2991	0.0894	(11)
	B.	1.9560	0.0892	0.0080	(10)
	C.	1.9140	0.1290	0.0166	(10)
	D.	1.8900	0.1229	0.0151	(10)
	E.	1.8584	0.0876	0.0077	(19)
	F.	1.8880	0.1326	0.0176	(10)
	G.	1.9450	0.0354	0.0013	(2)
	H.	1.8980	0.1321	0.0174	(10)
	I.	1.7685	0.0832	0.0069	(20)
	J.	1.7815	0.0796	0.0063	(20)
	K.	2.0770	0.1543	0.0238	(10)
	L.	1.9733	0.1280	0.0164	(6)
	M.	2.1883	0.1706	0.0291	(6)
	N.	2.3170	0.1337	0.0179	(20)
	O.	2.1506	0.2018	0.0407	(16)
	P.	2.0340	0.1245	0.0155	(10)
	Q.	2.0360	0.1777	0.0316	(10)
	R.	2.0954	0.1237	0.0153	(13)
	S.	2.0028	0.1532	0.0235	(18)
	T.	1.9510	0.1114	0.0124	(20)
	U.	1.8855	0.1217	0.0148	(20)
2.	M.	2.2320	0.1441	0.0208	(10)
	N.	2.4284	0.1090	0.0119	(19)
	O.	2.3124	0.2923	0.0854	(17)
	Q.	2.1130	0.1355	0.0184	(10)
	R.	2.0100	0.0000	0.0000	(1)
	T.	2.1470	0.1579	0.0249	(20)
	U.	1.9415	0.1415	0.0200	(20)
3.	N.	2.1050	0.2192	0.0480	(2)
	Q.	1.8200	0.0000	0.0000	(1)
4.	K.	3.6533	0.2871	0.0824	(3)
	L.	3.4522	0.1692	0.0286	(9)
	M.	3.8200	0.2176	0.0474	(5)
	N.	3.5176	0.2413	0.0582	(17)
	O.	3.5130	0.2774	0.0769	(10)
	P.	3.5550	0.2471	0.0611	(6)
	T.	3.3700	0.2302	0.0530	(9)
	U.	3.2067	0.4484	0.2010	(3)
5.	L.	2.9040	0.1750	0.0306	(5)
	M.	2.8920	0.2024	0.0410	(10)
	O.	2.9800	0.2218	0.0492	(4)
6.	G.	2.5160	0.1163	0.0135	(5)
	H.	2.8367	0.1986	0.0394	(3)
	K.	2.7900	0.1838	0.0338	(2)
	L.	2.4900	0.1600	0.0256	(9)
	M.	2.5700	0.1899	0.0360	(10)
	O.	2.5389	0.1090	0.0119	(9)
	Q.	2.5383	0.0668	0.0045	(6)
	R.	2.5225	0.1400	0.0196	(8)
	T.	2.5720	0.1535	0.0236	(5)
7.	R.	1.8659	0.1287	0.0166	(17)

Character C56 Mean Disc Floret Corolla Tube Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	0.8700	0.1008	0.0102	(11)
	B.	0.8430	0.0745	0.0056	(10)
	C.	0.7950	0.0784	0.0061	(10)
	D.	0.8480	0.0549	0.0030	(10)
	E.	0.8411	0.0659	0.0043	(19)
	F.	0.8920	0.0733	0.0054	(10)
	G.	0.8400	0.0283	0.0008	(2)
	H.	0.8560	0.0578	0.0033	(10)
	I.	0.7945	0.0803	0.0064	(20)
	J.	0.8015	0.0548	0.0030	(20)
	K.	0.8570	0.0585	0.0034	(10)
	L.	0.8600	0.0642	0.0041	(6)
	M.	0.7767	0.0378	0.0014	(6)
	N.	0.9235	0.0692	0.0048	(20)
	O.	0.9150	0.0822	0.0068	(16)
	P.	0.8590	0.0530	0.0028	(10)
	Q.	0.8270	0.0803	0.0064	(10)
	R.	0.9362	0.0761	0.0058	(13)
	S.	0.9028	0.0733	0.0054	(18)
	T.	0.8425	0.0663	0.0044	(20)
	U.	0.8235	0.0622	0.0039	(20)
2.	M.	0.8390	0.0703	0.0049	(10)
	N.	0.9000	0.0609	0.0037	(19)
	O.	0.9118	0.0606	0.0037	(17)
	Q.	0.8620	0.0547	0.0030	(10)
	R.	0.8300	0.0000	0.0000	(1)
	T.	0.8650	0.0584	0.0034	(20)
	U.	0.7915	0.0463	0.0021	(20)
3.	N.	0.8300	0.1273	0.0162	(2)
	Q.	0.7600	0.0000	0.0000	(1)
4.	K.	1.9333	0.1106	0.0122	(3)
	L.	1.7567	0.1632	0.0267	(9)
	M.	2.1100	0.2714	0.0736	(5)
	N.	1.8347	0.2501	0.0626	(17)
	O.	1.8190	0.1978	0.0391	(10)
	P.	1.8983	0.1607	0.0258	(6)
	T.	1.6956	0.0986	0.0097	(9)
	U.	1.6833	0.1007	0.0101	(3)
5.	L.	1.2780	0.0581	0.0034	(5)
	M.	1.2640	0.1206	0.0145	(10)
	O.	1.3750	0.0592	0.0035	(4)
6.	G.	1.1600	0.0784	0.0062	(5)
	H.	1.1533	0.0208	0.0004	(3)
	K.	1.1800	0.0283	0.0008	(2)
	L.	1.1489	0.0603	0.0036	(9)
	M.	1.1340	0.0420	0.0018	(10)
	O.	1.1700	0.0592	0.0035	(9)
	Q.	1.1283	0.0286	0.0008	(6)
	R.	1.1512	0.0810	0.0066	(8)
	T.	1.1560	0.0796	0.0063	(5)
7.	R.	0.6782	0.0566	0.0032	(17)

Character C57 Anther Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	1.1273	0.0876	0.0077	(11)
	B.	1.1200	0.0537	0.0029	(10)
	C.	1.1000	0.0745	0.0056	(10)
	D.	1.1550	0.0926	0.0086	(10)
	E.	1.0947	0.0685	0.0047	(19)
	F.	1.1600	0.0876	0.0077	(10)
	G.	1.3500	0.0707	0.0050	(2)
	H.	1.1350	0.0747	0.0056	(10)
	I.	1.1250	0.0574	0.0033	(20)
	J.	1.1650	0.0671	0.0045	(20)
	K.	1.2250	0.1112	0.0124	(10)
	L.	1.1500	0.0632	0.0040	(6)
	M.	1.2333	0.1033	0.0107	(6)
	N.	1.4350	0.1289	0.0166	(20)
	O.	1.2813	0.1195	0.0143	(16)
	P.	1.1950	0.0985	0.0097	(10)
	Q.	1.3450	0.0599	0.0036	(10)
	R.	1.3308	0.0830	0.0069	(13)
	S.	1.2778	0.1166	0.0136	(18)
	T.	1.1825	0.0748	0.0056	(20)
	U.	1.1550	0.0945	0.0089	(20)
2.	M.	1.3950	0.0550	0.0030	(10)
	N.	1.5316	0.0478	0.0023	(19)
	O.	1.4765	0.1161	0.0135	(17)
	Q.	1.4050	0.0896	0.0080	(10)
	R.	1.3500	0.0000	0.0000	(1)
	T.	1.3025	0.0835	0.0070	(20)
	U.	1.1875	0.0705	0.0050	(20)
3.	N.	1.5000	0.0707	0.0050	(2)
	Q.	1.3500	0.0000	0.0000	(1)
4.	K.	2.8500	0.1323	0.0175	(3)
	L.	2.5500	0.0935	0.0088	(9)
	M.	2.5800	0.1525	0.0232	(5)
	N.	2.6029	0.3120	0.0973	(17)
	O.	2.4750	0.1359	0.0185	(10)
	P.	2.4833	0.1602	0.0257	(6)
	T.	2.4722	0.1603	0.0257	(9)
	U.	2.5500	0.0500	0.0025	(3)
5.	L.	2.0400	0.0742	0.0055	(5)
	M.	2.0050	0.1363	0.0186	(10)
	O.	2.1500	0.1080	0.0117	(4)
6.	G.	1.7500	0.0935	0.0087	(5)
	H.	1.8167	0.0289	0.0008	(3)
	K.	1.7750	0.0354	0.0012	(2)
	L.	1.7444	0.0726	0.0053	(9)
	M.	1.7350	0.0580	0.0034	(10)
	O.	1.5889	0.3471	0.1205	(9)
	Q.	1.6750	0.0935	0.0088	(6)
	R.	1.6375	0.0991	0.0098	(8)
	T.	1.6900	0.0822	0.0067	(5)
7.	R.	0.9618	0.0650	0.0042	(17)

Character C58 Number Of Outer Florets

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	10.3636	1.3618	1.8545	(11)
	B.	10.1000	2.1833	4.7667	(10)
	C.	10.1000	2.1833	4.7667	(10)
	D.	10.1000	1.5239	2.3222	(10)
	E.	8.3684	2.2413	5.0234	(19)
	F.	8.6000	1.9551	3.8222	(10)
	G.	5.5000	2.1213	4.5000	(2)
	H.	7.9000	2.4698	6.1000	(10)
	I.	8.1500	1.6631	2.7658	(20)
	J.	7.6000	2.0365	4.1474	(20)
	K.	7.4000	2.5906	6.7111	(10)
	L.	9.0000	3.7417	14.0000	(6)
	M.	5.8333	3.3116	10.9667	(6)
	N.	5.7000	2.3418	5.4842	(20)
	O.	7.3125	2.3585	5.5625	(16)
	P.	6.3000	2.7508	7.5667	(10)
	Q.	7.4000	1.7127	2.9333	(10)
	R.	4.2308	2.3859	5.6923	(13)
	S.	5.0000	2.8491	8.1176	(18)
	T.	6.3000	2.3864	5.6947	(20)
	U.	8.1500	2.0844	4.3447	(20)
2.	M.	9.8000	1.6865	2.8444	(10)
	N.	12.0526	1.3112	1.7193	(19)
	O.	10.6471	1.9982	3.9926	(17)
	Q.	10.3000	1.6364	2.6778	(10)
	R.	9.0000	0.0000	0.0000	(1)
	T.	9.3000	1.5594	2.4316	(20)
	U.	10.9000	1.5861	2.5158	(20)
3.	N.	11.0000	2.8284	8.0000	(2)
	Q.	13.0000	0.0000	0.0000	(1)
4.	K.	13.0000	0.0000	0.0000	(3)
	L.	12.8889	0.3333	0.1111	(9)
	M.	13.0000	0.0000	0.0000	(5)
	N.	12.7647	0.9034	0.8162	(17)
	O.	12.7000	0.6749	0.4556	(10)
	P.	12.3333	1.3663	1.8667	(6)
	T.	12.8889	0.3333	0.1111	(9)
	U.	13.0000	0.0000	0.0000	(3)
5.	L.	13.0000	0.0000	0.0000	(5)
	M.	12.5000	1.5811	2.5000	(10)
	O.	13.0000	0.0000	0.0000	(4)
6.	G.	13.0000	0.0000	0.0000	(5)
	H.	13.0000	0.0000	0.0000	(3)
	K.	13.0000	0.0000	0.0000	(2)
	L.	13.0000	0.0000	0.0000	(9)
	M.	13.0000	0.0000	0.0000	(10)
	O.	13.0000	0.0000	0.0000	(9)
	Q.	13.0000	0.0000	0.0000	(6)
	R.	13.0000	0.0000	0.0000	(8)
	T.	13.0000	0.0000	0.0000	(5)
7.	R.	11.9412	1.1440	1.3088	(17)

Character C59 Mean Outer Floret Length

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	1.6045	0.0619	0.0038	(11)
	B.	1.6190	0.0985	0.0097	(10)
	C.	1.5140	0.0548	0.0030	(10)
	D.	1.5290	0.1306	0.0171	(10)
	E.	1.5411	0.0652	0.0043	(19)
	F.	1.5260	0.0640	0.0041	(10)
	G.	1.6000	0.0283	0.0008	(2)
	H.	1.6810	0.0946	0.0089	(10)
	I.	1.5195	0.0575	0.0033	(20)
	J.	1.5180	0.0731	0.0053	(20)
	K.	1.8230	0.2108	0.0444	(10)
	L.	1.7067	0.0836	0.0070	(6)
	M.	1.9367	0.1172	0.0137	(6)
	N.	1.9930	0.1106	0.0122	(20)
	O.	1.8850	0.1658	0.0275	(16)
	P.	1.8710	0.1675	0.0281	(10)
	Q.	1.9420	0.1195	0.0143	(10)
	R.	1.9100	0.1457	0.0212	(13)
	S.	1.8206	0.1427	0.0204	(18)
	T.	1.7020	0.1233	0.0152	(20)
	U.	1.6815	0.1299	0.0169	(20)
2.	M.	4.9990	0.2049	0.0420	(10)
	N.	5.3321	0.5976	0.3571	(19)
	O.	4.9576	0.4320	0.1866	(17)
	Q.	4.3660	0.1535	0.0236	(10)
	R.	4.9100	0.0000	0.0000	(1)
	T.	5.0335	0.4470	0.1998	(20)
	U.	4.3140	0.2053	0.0421	(20)
3.	N.	3.0400	0.4384	0.1922	(2)
	Q.	3.2600	0.0000	0.0000	(1)
4.	K.	10.5000	0.7234	0.5233	(3)
	L.	11.0567	1.6130	2.6019	(9)
	M.	10.9200	0.9988	0.9977	(5)
	N.	11.5665	1.6240	2.6373	(17)
	O.	10.9190	1.2533	1.5709	(10)
	P.	10.2533	1.0277	1.0562	(6)
	T.	11.3167	1.6389	2.6860	(9)
	U.	10.7333	1.0961	1.2014	(3)
5.	L.	7.6280	0.3939	0.1552	(5)
	M.	7.5660	0.5268	0.2775	(10)
	O.	8.4600	0.6159	0.3793	(4)
6.	G.	6.4740	0.3211	0.1031	(5)
	H.	6.4567	0.3889	0.1512	(3)
	K.	6.6450	0.3889	0.1513	(2)
	L.	6.7633	0.4240	0.1798	(9)
	M.	6.4200	0.4785	0.2290	(10)
	O.	6.4756	0.4276	0.1828	(9)
	Q.	6.5200	0.6760	0.4569	(6)
	R.	6.4312	0.5418	0.2935	(8)
	T.	6.5060	0.2339	0.0547	(5)
7.	R.	2.7459	0.1353	0.0183	(17)

Character C61 Mean Outer Floret Width

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	0.8136	0.0707	0.0050	(11)
	B.	0.8340	0.0902	0.0081	(10)
	C.	0.8310	0.0441	0.0019	(10)
	D.	0.8160	0.0513	0.0026	(10)
	E.	0.8779	0.0805	0.0065	(19)
	F.	0.8710	0.0860	0.0074	(10)
	G.	0.7750	0.0636	0.0040	(2)
	H.	0.8950	0.1009	0.0102	(10)
	I.	0.7855	0.0874	0.0076	(20)
	J.	0.8175	0.0733	0.0054	(20)
	K.	0.9230	0.1397	0.0195	(10)
	L.	0.9117	0.0768	0.0059	(6)
	M.	0.8250	0.0887	0.0079	(6)
	N.	0.9130	0.0856	0.0073	(20)
	O.	0.8956	0.0776	0.0060	(16)
	P.	0.9200	0.0994	0.0099	(10)
	Q.	0.8410	0.0702	0.0049	(10)
	R.	0.8923	0.1022	0.0105	(13)
	S.	0.8656	0.0979	0.0096	(18)
	T.	0.7975	0.0840	0.0071	(20)
	U.	0.8805	0.0715	0.0051	(20)
2.	M.	1.2730	0.0495	0.0024	(10)
	N.	1.3584	0.1402	0.0197	(19)
	O.	1.3724	0.0791	0.0063	(17)
	Q.	1.2400	0.0632	0.0040	(10)
	R.	1.2800	0.0000	0.0000	(1)
	T.	1.4025	0.0959	0.0092	(20)
	U.	1.3270	0.1366	0.0187	(20)
3.	N.	1.1150	0.0495	0.0024	(2)
	Q.	1.1900	0.0000	0.0000	(1)
4.	K.	2.9267	0.1474	0.0217	(3)
	L.	2.9711	0.3197	0.1022	(9)
	M.	3.3480	0.3789	0.1436	(5)
	N.	3.4859	0.5861	0.3436	(17)
	O.	3.3400	0.3769	0.1421	(10)
	P.	3.2317	0.4744	0.2250	(6)
	T.	3.2411	0.4098	0.1680	(9)
	U.	3.4367	0.6901	0.4762	(3)
5.	L.	1.7660	0.2458	0.0604	(5)
	M.	1.7430	0.2876	0.0827	(10)
	O.	2.0550	0.1984	0.0394	(4)
6.	G.	0.9700	0.0886	0.0078	(5)
	H.	1.1433	0.0513	0.0026	(3)
	K.	1.0000	0.0566	0.0032	(2)
	L.	0.9256	0.0623	0.0039	(9)
	M.	0.9800	0.1139	0.0130	(10)
	O.	0.9522	0.1461	0.0213	(9)
	Q.	0.9433	0.0726	0.0053	(6)
	R.	1.0400	0.1273	0.0162	(8)
	T.	0.9840	0.0305	0.0009	(5)
7.	R.	0.7112	0.0521	0.0027	(17)

Character C62 Mean Outer Floret Ray Gland Density

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	0.0000	0.0000	0.0000	(11)
	B.	0.0000	0.0000	0.0000	(10)
	C.	0.0000	0.0000	0.0000	(10)
	D.	0.0000	0.0000	0.0000	(10)
	E.	0.0000	0.0000	0.0000	(19)
	F.	0.0000	0.0000	0.0000	(10)
	G.	0.0000	0.0000	0.0000	(2)
	H.	0.0000	0.0000	0.0000	(10)
	I.	0.0000	0.0000	0.0000	(20)
	J.	0.0000	0.0000	0.0000	(20)
	K.	0.0000	0.0000	0.0000	(10)
	L.	0.0000	0.0000	0.0000	(6)
	M.	0.0000	0.0000	0.0000	(6)
	N.	0.0000	0.0000	0.0000	(20)
	O.	0.0000	0.0000	0.0000	(16)
	P.	0.0000	0.0000	0.0000	(10)
	Q.	0.0000	0.0000	0.0000	(10)
	R.	0.0000	0.0000	0.0000	(13)
	S.	0.0000	0.0000	0.0000	(18)
	T.	0.0000	0.0000	0.0000	(20)
	U.	0.0000	0.0000	0.0000	(20)
2.	M.	0.0000	0.0000	0.0000	(10)
	N.	0.0000	0.0000	0.0000	(19)
	O.	0.0000	0.0000	0.0000	(17)
	Q.	0.0000	0.0000	0.0000	(10)
	R.	0.0000	0.0000	0.0000	(1)
	T.	0.0000	0.0000	0.0000	(20)
	U.	0.0000	0.0000	0.0000	(20)
3.	N.	0.0000	0.0000	0.0000	(2)
	Q.	0.0000	0.0000	0.0000	(1)
4.	K.	4.8667	0.9609	0.9233	(3)
	L.	6.4778	4.4491	19.7944	(9)
	M.	7.9800	3.5745	12.7770	(5)
	N.	9.0412	2.6982	7.2801	(17)
	O.	7.0200	3.5301	12.4618	(10)
	P.	6.1333	6.0292	36.3507	(6)
	T.	6.3222	2.9685	8.8119	(9)
	U.	6.9333	2.4173	5.8433	(3)
5.	L.	17.6800	3.0987	9.6020	(5)
	M.	14.5600	4.6940	22.0338	(10)
	O.	17.4000	4.3413	18.8467	(4)
6.	G.	8.8400	2.8711	8.2430	(5)
	H.	7.8333	2.0984	4.4033	(3)
	K.	8.8000	5.3740	28.8800	(2)
	L.	8.0556	2.0372	4.1503	(9)
	M.	10.4100	2.8575	8.1654	(10)
	O.	8.9444	3.0402	9.2428	(9)
	Q.	8.5667	2.6508	7.0267	(6)
	R.	9.9750	2.9937	8.9621	(8)
	T.	8.4800	2.6042	6.7820	(5)
7.	R.	3.8059	1.9518	3.8093	(17)

Character C63 Mean Outer Floret Tube Gland Density

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	0.0000	0.0000	0.0000	(11)
	B.	0.0000	0.0000	0.0000	(10)
	C.	0.0000	0.0000	0.0000	(10)
	D.	0.0000	0.0000	0.0000	(10)
	E.	0.0000	0.0000	0.0000	(19)
	F.	0.0000	0.0000	0.0000	(10)
	G.	0.0000	0.0000	0.0000	(2)
	H.	0.0000	0.0000	0.0000	(10)
	I.	0.0000	0.0000	0.0000	(20)
	J.	0.0000	0.0000	0.0000	(20)
	K.	0.0000	0.0000	0.0000	(10)
	L.	0.0000	0.0000	0.0000	(6)
	M.	0.0000	0.0000	0.0000	(6)
	N.	0.0000	0.0000	0.0000	(20)
	O.	0.0000	0.0000	0.0000	(16)
	P.	0.0000	0.0000	0.0000	(10)
	Q.	0.0000	0.0000	0.0000	(10)
	R.	0.0000	0.0000	0.0000	(13)
	S.	0.0000	0.0000	0.0000	(18)
	T.	0.0000	0.0000	0.0000	(20)
	U.	0.0000	0.0000	0.0000	(20)
2.	M.	0.0000	0.0000	0.0000	(10)
	N.	0.0000	0.0000	0.0000	(19)
	O.	0.0000	0.0000	0.0000	(17)
	Q.	0.0000	0.0000	0.0000	(10)
	R.	0.0000	0.0000	0.0000	(1)
	T.	0.0000	0.0000	0.0000	(20)
	U.	0.0000	0.0000	0.0000	(20)
3.	N.	0.0000	0.0000	0.0000	(2)
	Q.	0.0000	0.0000	0.0000	(1)
4.	K.	66.3333	11.3298	128.3633	(3)
	L.	66.8333	9.7591	95.2400	(9)
	M.	74.0800	19.5974	384.0570	(5)
	N.	75.1000	14.6700	215.2087	(17)
	O.	76.4600	16.1615	261.1938	(10)
	P.	53.9500	23.5935	556.6550	(6)
	T.	75.2000	18.0710	326.5600	(9)
	U.	66.0667	11.5154	132.6033	(3)
5.	L.	30.0000	5.5150	30.4150	(5)
	M.	32.0900	9.4473	89.2521	(10)
	O.	26.5250	5.3711	28.8492	(4)
6.	G.	1.7000	0.8860	0.7850	(5)
	H.	1.6667	0.8622	0.7433	(3)
	K.	2.1500	1.3435	1.8050	(2)
	L.	1.6333	0.7517	0.5650	(9)
	M.	2.2500	1.5714	2.4694	(10)
	O.	1.9667	1.4177	2.0100	(9)
	Q.	1.7667	0.8779	0.7707	(6)
	R.	1.9000	1.6458	2.7086	(8)
	T.	1.7000	0.8367	0.7000	(5)
7.	R.	2.0882	1.2155	1.4774	(17)

Character C64 Outer Floret Anther Class

Spp.	Popn	Mean	Std. Dev.	Variance	n.
1.	A.	6.0000	0.0000	0.0000	(11)
	B.	6.0000	0.0000	0.0000	(10)
	C.	6.0000	0.0000	0.0000	(10)
	D.	6.0000	0.0000	0.0000	(10)
	E.	6.0000	0.0000	0.0000	(19)
	F.	6.0000	0.0000	0.0000	(10)
	G.	6.0000	0.0000	0.0000	(2)
	H.	6.0000	0.0000	0.0000	(10)
	I.	6.0000	0.0000	0.0000	(20)
	J.	6.0000	0.0000	0.0000	(20)
	K.	6.0000	0.0000	0.0000	(10)
	L.	6.0000	0.0000	0.0000	(6)
	M.	6.0000	0.0000	0.0000	(6)
	N.	6.0000	0.0000	0.0000	(20)
	O.	6.0000	0.0000	0.0000	(16)
	P.	6.0000	0.0000	0.0000	(10)
	Q.	6.0000	0.0000	0.0000	(10)
	R.	6.0000	0.0000	0.0000	(13)
	S.	6.0000	0.0000	0.0000	(18)
	T.	6.0000	0.0000	0.0000	(20)
	U.	6.0000	0.0000	0.0000	(20)
2.	M.	3.0000	0.0000	0.0000	(10)
	N.	2.9474	0.2294	0.0526	(19)
	O.	3.0000	0.0000	0.0000	(17)
	Q.	2.8000	0.6325	0.4000	(10)
	R.	3.0000	0.0000	0.0000	(1)
	T.	3.0000	0.0000	0.0000	(20)
	U.	3.0000	0.0000	0.0000	(20)
3.	N.	5.0000	0.0000	0.0000	(2)
	Q.	5.0000	0.0000	0.0000	(1)
4.	K.	0.6667	0.5774	0.3333	(3)
	L.	0.3333	0.7071	0.5000	(9)
	M.	0.2000	0.4472	0.2000	(5)
	N.	0.2353	0.6642	0.4412	(17)
	O.	0.3000	0.6749	0.4556	(10)
	P.	0.3333	0.5164	0.2667	(6)
	T.	0.1111	0.3333	0.1111	(9)
	U.	0.0000	0.0000	0.0000	(3)
5.	L.	0.0000	0.0000	0.0000	(5)
	M.	0.0000	0.0000	0.0000	(10)
	O.	0.0000	0.0000	0.0000	(4)
6.	G.	0.0000	0.0000	0.0000	(5)
	H.	0.0000	0.0000	0.0000	(3)
	K.	0.0000	0.0000	0.0000	(2)
	L.	0.0000	0.0000	0.0000	(9)
	M.	0.0000	0.0000	0.0000	(10)
	O.	0.0000	0.0000	0.0000	(9)
	Q.	0.0000	0.0000	0.0000	(6)
	R.	0.0000	0.0000	0.0000	(8)
	T.	0.0000	0.0000	0.0000	(5)
7.	R.	0.0000	0.0000	0.0000	(17)

Character C421 SQRT Max Phyllary Hair Density

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	0.0000	0.0000	0.0000	(11)
	B.	0.0000	0.0000	0.0000	(10)
	C.	0.0000	0.0000	0.0000	(10)
	D.	0.0000	0.0000	0.0000	(10)
	E.	0.1579	0.3746	0.1404	(19)
	F.	0.1000	0.3162	0.1000	(10)
	G.	0.0000	0.0000	0.0000	(2)
	H.	0.2000	0.4216	0.1778	(10)
	I.	0.1500	0.3663	0.1342	(20)
	J.	0.1500	0.3663	0.1342	(20)
	K.	0.0000	0.0000	0.0000	(10)
	L.	0.0000	0.0000	0.0000	(6)
	M.	0.5000	0.5477	0.3000	(6)
	N.	0.7694	0.6138	0.3768	(20)
	O.	0.5777	0.6143	0.3774	(16)
	P.	0.2000	0.4216	0.1778	(10)
	Q.	0.1000	0.3162	0.1000	(10)
	R.	0.2308	0.4385	0.1923	(13)
	S.	0.1667	0.3835	0.1471	(18)
	T.	0.2914	0.5282	0.2790	(20)
	U.	0.3707	0.5257	0.2764	(20)
2.	M.	0.9064	0.7290	0.5315	(10)
	N.	0.7355	0.6111	0.3734	(19)
	O.	0.4605	0.5807	0.3372	(17)
	Q.	0.6414	0.5663	0.3206	(10)
	R.	0.0000	0.0000	0.0000	(1)
	T.	0.9523	0.6010	0.3612	(20)
	U.	0.3914	0.5589	0.3124	(20)
3.	N.	0.0000	0.0000	0.0000	(2)
	Q.	0.0000	0.0000	0.0000	(1)
4.	K.	0.0000	0.0000	0.0000	(3)
	L.	0.2222	0.4410	0.1944	(9)
	M.	0.2000	0.4472	0.2000	(5)
	N.	0.1765	0.3930	0.1544	(17)
	O.	0.4414	0.5823	0.3391	(10)
	P.	0.4024	0.6370	0.4057	(6)
	T.	0.2222	0.4410	0.1944	(9)
	U.	0.3333	0.5774	0.3333	(3)
5.	L.	0.6828	0.6459	0.4172	(5)
	M.	0.3732	0.6331	0.4008	(10)
	O.	0.7866	0.9175	0.8418	(4)
6.	G.	0.4000	0.5477	0.3000	(5)
	H.	0.0000	0.0000	0.0000	(3)
	K.	0.5000	0.7071	0.5000	(2)
	L.	0.2222	0.4410	0.1944	(9)
	M.	0.4414	0.5823	0.3391	(10)
	O.	0.5365	0.6528	0.4262	(9)
	Q.	0.5690	0.6414	0.4114	(6)
	R.	0.5000	0.5345	0.2857	(8)
	T.	0.4000	0.5477	0.3000	(5)
7.	R.	8.9415	1.0264	1.0534	(17)

Character C431 SQRT Max Phyllary Gland Density

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	0.1286	0.4264	0.1818	(11)
	B.	0.0000	0.0000	0.0000	(10)
	C.	0.0000	0.0000	0.0000	(10)
	D.	0.0000	0.0000	0.0000	(10)
	E.	0.2105	0.4189	0.1754	(19)
	F.	0.3732	0.6331	0.4008	(10)
	G.	0.8660	1.2247	1.5000	(2)
	H.	1.6100	0.7513	0.5644	(10)
	I.	0.6987	0.6972	0.4861	(20)
	J.	0.2707	0.4885	0.2386	(20)
	K.	0.0000	0.0000	0.0000	(10)
	L.	0.0000	0.0000	0.0000	(6)
	M.	1.0696	1.1946	1.4271	(6)
	N.	1.5415	1.0124	1.0250	(20)
	O.	1.4341	0.7345	0.5395	(16)
	P.	0.8064	0.7815	0.6107	(10)
	Q.	0.5560	0.7385	0.5453	(10)
	R.	2.1103	0.6522	0.4254	(13)
	S.	2.4961	1.1338	1.2854	(18)
	T.	1.9318	0.8695	0.7560	(20)
	U.	1.8433	0.7270	0.5286	(20)
2.	M.	1.8996	0.6595	0.4349	(10)
	N.	1.9401	0.7632	0.5824	(19)
	O.	1.9126	0.6027	0.3632	(17)
	Q.	1.5609	0.9795	0.9595	(10)
	R.	1.4142	0.0000	0.0000	(1)
	T.	2.8089	0.7678	0.5896	(20)
	U.	2.2044	0.8213	0.6746	(20)
3.	N.	1.7321	2.4495	6.0000	(2)
	Q.	0.0000	0.0000	0.0000	(1)
4.	K.	2.2088	1.9188	3.6818	(3)
	L.	2.0954	1.4783	2.1853	(9)
	M.	4.5509	0.7823	0.6120	(5)
	N.	3.6142	1.1974	1.4337	(17)
	O.	3.6904	1.4068	1.9789	(10)
	P.	2.2879	2.3062	5.3186	(6)
	T.	1.8490	1.0742	1.1539	(9)
	U.	3.4499	0.8047	0.6476	(3)
5.	L.	12.3049	0.9927	0.9854	(5)
	M.	12.1716	0.6246	0.3901	(10)
	O.	12.1634	0.8582	0.7365	(4)
6.	G.	14.0599	1.2836	1.6476	(5)
	H.	14.3529	2.1192	4.4910	(3)
	K.	13.9362	2.5623	6.5655	(2)
	L.	14.5023	1.2328	1.5197	(9)
	M.	14.6840	1.4836	2.2010	(10)
	O.	14.1907	1.5252	2.3263	(9)
	Q.	14.2737	1.4537	2.1131	(6)
	R.	13.8100	1.3243	1.7538	(8)
	T.	14.1250	1.5345	2.3547	(5)
7.	R.	6.2191	0.6837	0.4675	(17)

Character C461 SQRT Mean Calyc Bract Hair Density

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	0.7961	0.2299	0.0529	(11)
	B.	0.9441	0.2323	0.0540	(10)
	C.	0.8713	0.2130	0.0454	(10)
	D.	0.8714	0.1517	0.0230	(10)
	E.	0.7506	0.2229	0.0497	(19)
	F.	0.9679	0.4125	0.1702	(10)
	G.	1.1368	0.1244	0.0155	(2)
	H.	0.5155	0.1257	0.0158	(10)
	I.	0.8065	0.3071	0.0943	(20)
	J.	0.8540	0.2526	0.0638	(20)
	K.	0.7407	0.3187	0.1016	(10)
	L.	0.7715	0.2138	0.0457	(6)
	M.	0.6507	0.1092	0.0119	(6)
	N.	0.9148	0.2130	0.0454	(20)
	O.	0.9213	0.1674	0.0280	(16)
	P.	0.7571	0.1724	0.0297	(10)
	Q.	0.4103	0.1138	0.0130	(10)
	R.	0.8702	0.3234	0.1046	(13)
	S.	0.8696	0.2531	0.0641	(18)
	T.	0.8871	0.1719	0.0296	(20)
	U.	0.8305	0.2621	0.0687	(20)
2.	M.	0.7229	0.1747	0.0305	(10)
	N.	0.9270	0.1437	0.0206	(19)
	O.	0.9219	0.2906	0.0844	(17)
	Q.	0.8244	0.2118	0.0449	(10)
	R.	1.0954	0.0000	0.0000	(1)
	T.	0.7537	0.2845	0.0810	(20)
	U.	1.0430	0.2851	0.0813	(20)
3.	N.	0.9427	0.1500	0.0225	(2)
	Q.	0.4472	0.0000	0.0000	(1)
4.	K.	0.2545	0.2299	0.0529	(3)
	L.	0.1902	0.2435	0.0593	(9)
	M.	0.7915	0.1304	0.0170	(5)
	N.	0.2863	0.2381	0.0567	(17)
	O.	0.3713	0.2831	0.0801	(10)
	P.	0.3020	0.4129	0.1705	(6)
	T.	0.3091	0.2599	0.0675	(9)
	U.	0.1054	0.1826	0.0333	(3)
5.	L.	1.3195	0.1540	0.0237	(5)
	M.	1.2956	0.2144	0.0460	(10)
	O.	1.2641	0.7091	0.5028	(4)
6.	G.	0.0000	0.0000	0.0000	(5)
	H.	0.1491	0.2582	0.0667	(3)
	K.	0.1581	0.2236	0.0500	(2)
	L.	0.2048	0.2008	0.0403	(9)
	M.	0.3209	0.2518	0.0634	(10)
	O.	0.5599	0.3672	0.1348	(9)
	Q.	0.2942	0.5798	0.3361	(6)
	R.	0.0395	0.1118	0.0125	(8)
	T.	0.1265	0.2828	0.0800	(5)
7.	R.	6.1163	0.3996	0.1596	(17)

Character C471 SQRT Mean Calyc Bract Gland Density

Spp.	Popn.	Mean	Std. Dev.	Variance	n.
1.	A.	0.5212	0.3622	0.1312	(11)
	B.	0.4304	0.1281	0.0164	(10)
	C.	0.4596	0.1787	0.0319	(10)
	D.	0.4968	0.2191	0.0480	(10)
	E.	0.3629	0.2354	0.0554	(19)
	F.	0.4234	0.1092	0.0119	(10)
	G.	0.4975	0.0711	0.0051	(2)
	H.	0.3740	0.1059	0.0112	(10)
	I.	0.4098	0.1837	0.0338	(20)
	J.	0.4161	0.2446	0.0598	(20)
	K.	0.3282	0.2834	0.0803	(10)
	L.	0.3290	0.1735	0.0301	(6)
	M.	0.4749	0.1715	0.0294	(6)
	N.	0.6980	0.2358	0.0556	(20)
	O.	0.6970	0.2349	0.0552	(16)
	P.	0.2836	0.2780	0.0773	(10)
	Q.	0.2576	0.1933	0.0374	(10)
	R.	0.5867	0.3792	0.1438	(13)
	S.	0.8475	0.3228	0.1042	(18)
	T.	0.6383	0.2858	0.0817	(20)
	U.	0.5918	0.2897	0.0839	(20)
2.	M.	0.5301	0.2080	0.0433	(10)
	N.	0.7837	0.1714	0.0294	(19)
	O.	0.7301	0.2288	0.0523	(17)
	Q.	0.4821	0.2299	0.0528	(10)
	R.	1.0488	0.0000	0.0000	(1)
	T.	0.5931	0.2475	0.0613	(20)
	U.	0.7835	0.2204	0.0486	(20)
3.	N.	0.8008	0.1325	0.0175	(2)
	Q.	0.3162	0.0000	0.0000	(1)
4.	K.	0.2545	0.2299	0.0529	(3)
	L.	0.3900	0.3590	0.1289	(9)
	M.	0.4813	0.1020	0.0104	(5)
	N.	0.1609	0.2179	0.0475	(17)
	O.	0.2969	0.2156	0.0465	(10)
	P.	0.2326	0.2740	0.0750	(6)
	T.	0.3042	0.2888	0.0834	(9)
	U.	0.2981	0.2582	0.0667	(3)
5.	L.	8.8217	1.0472	1.0965	(5)
	M.	8.6093	1.2204	1.4893	(10)
	O.	8.2239	0.8504	0.7231	(4)
6.	G.	11.7520	0.7826	0.6125	(5)
	H.	12.3672	0.2789	0.0778	(3)
	K.	11.4334	0.5937	0.3525	(2)
	L.	11.9271	0.5693	0.3241	(9)
	M.	12.0693	0.6510	0.4238	(10)
	O.	11.8273	0.7609	0.5790	(9)
	Q.	11.9940	1.0070	1.0140	(6)
	R.	12.1774	0.9007	0.8113	(8)
	T.	12.3492	0.8927	0.7969	(5)
7.	R.	2.0238	0.3133	0.0982	(17)